Syllabus

Environmental Studies
Course Code : EVS101

Course Contents:

Module - I: Multidisciplinary Nature of Environmental Studies and Natural Resources

Multidisciplinary Nature of Environmental Studies: Introduction, Definition and Importance of Environmental Studies, Need for Public Awareness, Sensitization and Participation.

Natural Resources: (1) Types of Natural Resources, Natural Resource Conservation, Role of an Individual in Conservation of Natural Resources, Equitable Use of Resources for Sustainable Lifestyles. (2) Land Resources: Land as a Resource, Land Degradation, Man-induced Landslides, Soil Erosion and Desertification. (3) Forest Resources: Use and Overexploitation, Deforestation, Case Studies, Timber Extraction, Mining, Dams, and their Effects on Forests and Tribal People. (4) Water Resources: Use and Overutilization of Surface and Ground Water, Floods, Drought, Conflicts over Water, Dams – Benefits and Problems. (5) Mineral Resources: Use and Exploitation, Environmental Effects of Extracting and Using Mineral Resources, Case Studies. (6) Food Resources: World Food Problems, Changes Caused by Agriculture and Overgrazing, Effects of Modern Agriculture, Fertilizer-Pesticide Problems, Water Logging, Salinity, Case Studies. (7) Energy Resources: Growing Energy Needs, Renewable and Non-renewable Energy Sources, Use of Alternate Energy Sources, Case Studies.

Module - II: Ecosystems

Ecosystems: Concept of an Ecosystem, Types of Ecosystem, Structure and Function of an Ecosystem, Producers, Consumers and Decomposers, Energy Flow in the Ecosystem, Food Chains, Food Webs and Ecological Pyramids, Ecological Succession, Introduction, Types, Characteristic Features, Structure and Function of Forest Ecosystem, Grassland Ecosystem and Desert Ecosystem, Aquatic Ecosystems (Ponds, Streams, Lakes, Rivers and Ocean Estuaries).

Module - III: Environmental Pollution

Environmental Pollution: Definition, Causes, Effects and Control Measures of: (a) Air Pollution, (b) Water Pollution, (c) Soil Pollution, (d) Marine Pollution, (e) Noise Pollution, (f) Thermal Pollution, (g) Nuclear Hazards, Solid Waste Management: Causes, Effects and Control Measures of Urban and Industrial Wastes, Role of an Individual in Prevention of Pollution, Pollution – Case Studies, Disaster Management: Floods, Earthquakes, Cyclones and Landslides.

Module - IV: Social Issues and the Environment and Human Population and the Environment

Social Issues and the Environment: Environment from Unsustainable to Sustainable Development, Urban Problems Related to Energy Water Conservation, Rainwater Harvesting, Watershed Management, Resettlement and Rehabilitation of People: Its Problems and Concerns, Case Studies, Environmental Ethics: Issues and Possible Solutions, Climate Change, Global Warming, Acid Rain, Ozone Layer Depletion, Nuclear Accidents and Holocaust, Case Studies, Wasteland Reclamation, Consumerism and Waste Products. Environment (Protection) Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife (Protection) Act, Forest (Conservation) Act, Issues Involved in Enforcement of Environmental Legislation, Public Awareness.

Human Population and the Environment: Population Growth, Variation among Nations, Population Explosion – Family Welfare Programme, Environment and Human Health, Human Rights, Value Education, HIV/AIDS, Women and Child Welfare, Role of Information Technology in Environment and Human Health, Case Studies.

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Module - V: Biodiversity

Biodiversity: Introduction – Definition: Genetic, Species and Ecosystem Diversity, Bio-geographical Classification of India, Value of Biodiversity: Consumptive Use, Productive Use, Social Use, Ethical Use, Aesthetic Use and Option Values, Biodiversity at Global, National and Local Levels, India as a Mega-diversity Nation, Hotspots of Biodiversity, Threats to Biodiversity: Habitat Loss, Poaching of Wildlife, Man-Wildlife Conflicts, Endangered and Endemic Species of India, Conservation of Biodiversity: *In-situ* and *Ex-situ* Conservation of Biodiversity, Biological Diversity Act, 2002.

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Module 1: Multidisciplinary Nature of Environmental Studies and Natural Resources

Unit I: Multidisciplinary Nature of Environmental Studies

Structure:

Objectives

After studying this unit, you should be able to:

- Understand the multidisciplinary nature of environmental studies
- Describe the importance, need, scope and public awareness of environmental studies
- Write about natural resources and their consumption as well as overexploitation
- Explain the different types of ecosystem and energy flow

1.1 Introduction

'Environment' is derived from the French word 'Environner' which means to encircle or surround. All the biological and non-biological things surrounding an organism are thus included in environment. Hence, environment is a summation of air, water and land, interdependent amongst them and along with the humans, many different life forms and goods. Therefore, the classification specified in the Environment Protection Act, 1986 evidently shows the atmosphere comprises of entire bodily and organic surroundings and its interactions. For orderly study of environment, one needs to have the information of several disciplines. To understand biotic components, life sciences cover. Botany, Zoology, Microbiology, Genetics, etc. Fundamental concept of Physical Sciences help in Geology, Oceanography and Atmospheric Science. Information technology helps in studying models.

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1.2 Definition and Importance

Definition

Environment is the sum total of water, air and land interrelationships among themselves and also with the human beings, other living organisms and property.

The extent of ecological lessons is far-reaching and it incorporates larger zones and features, mainly detailed under:

- Natural Resources – its preservation and administration
- Biology and ecological variety
- Ecological contamination and regulation
- Societal matters with regards to a growing ecosystem
- Inhabitants and ecosystem

These are some of the essential features of Ecological Lessons that are directly pertinent to each segment of the social order. Ecological lessons can be extremely specific, which may also focus on much more practical features like Atmosphere Sciences, Ecological Business, Ecosystem Administration, Ecological Bioengineering, etc.

We all belong to the environment; hence, the environment is important for all. No matter what occupation or the age of a person is, one shall be impacted by ecosystem and will also influence the ecosystem by their actions. Therefore, ecosystem is such a topic which is truly universal. For instance, environment is limitless and the toxins formed at a single location can spread to many more locations. The marine contamination in our organic assets by manufacturing or civic release will extremely disturb the water life forms of flora and fauna. Harm to the woodlands in a rocky area will have an extensive result on the mountains and on grasslands as well. It is due to the ecosystem being a meticulous and complex intertwined link of mechanisms and purposes. Here are ecological difficulties that carry local significance and few prime matters like greenhouse effect, shrinking of isothermal layer, dwindling woodlands and natural assets, damage of worldwide ecological variety, etc. will impact the entire human species and one has to anticipate globally. For handling domestic ecological matters, e.g., the effects of taking out minerals or hydroelectric developments, hard waste matter administration, etc., we must contemplate and take actions domestically. To educate people and make them alert of the facets of ecosystem by which they are closely related, it is vital to teach each individual about the environment.

Ecological lessons are imperative, as it looks after the everyday ordinary problems such as harmless and hygienic consuming water, clean surroundings, pure air, productive soil, nutritious diet and growth which is maintainable. There is a necessity for skilled workforce at each stage to handle ecological problems. Conservational rules, commercial management and ecological production are evolving as fresh profession prospects for ecological safety and administration. With the effluence regulations and rules getting stricter, businesses are facing difficulties to discard the formed waste matter. To evade costly lawsuit, several businesses are looking to implement and develop eco-friendly machineries, that will decrease effluence. Investment in effluence regulation machineries will decrease contamination and demonstrate budget-friendly for sewage handling. Marketplace for effluence regulation technologies is massive and has spread worldwide. Cleansing of the sewage formed is one more probable marketplace. It is projected to be furthermore than $100 billion per year for all American companies. Germany and Japan have additional severe rules since several ages and have acquired extra knowledge in decreasing waste. There is still a $200 billion marketplace for

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cleansing up the previous East Germany entirely. In our nation too, the Pollution Control Boards are applying effluence regulation rules and asserting on treating the sewages to reach the given benchmarks prior to letting it out into a water body or land. Several companies that did not comply with the guidelines are shut down or commanded to move. It is crucial if we wish to exist in a hygienic, well, visually appealing, safe atmosphere for many centuries and desire to leave back a hygienic and harmless planet to our future generations.

1.3 Need for Public Awareness

The United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, commonly recognised as 'Earth Summit' tailed by the World Summit on Sustainable Development at Johannesburg in 2002, right after 10 years of the initial conference, has emphasised on the main problems of universal ecological fear and has involved the consideration of the common people in the direction of the degenerating atmosphere. Administration at its individual stage fails to attain the targets of maintainable growth till the nation's common people actively participate in it. Community contribution is probable only if they are made mindful of the environmental and conservation problems. Government's decision to prohibit the disposal of polyethylene won't be fruitful till the community understands its consequences on the environment. The citizens have to be taught regarding the circumstances. If we deteriorate our atmosphere, we will cause harm to ourselves because we belong to the multifaceted link of ecosystem, wherein each constituent is connected to one another. It is extremely imperative to teach individuals the adverse effects of poorly maintained atmosphere, sometimes which is not faced or observed till a verge is overlapped. Thus, we are perhaps trapped uninformed by a calamity.

A Chinese saying states "If you plan for one year, plant rice; if you plan for 10 years, plant trees and if you plan for 100 years, educate people." If we wish to handle our planet earth, we must make all individuals ecologically informed. In 1991, the Supreme Court of India published an order to execute any programmes focusing on the environment. This order was in answer to a Public Interest Litigation (PIL) filed by *M.C. Mehta v. Union of India* (1988) which encouraged the summit law court to command an order for generating ecological alertness amongst all the inhabitants of the country.

Everyone discusses of the ecosystem, but very few have distinct thoughts of what actions are needed to be taken and a very few have the real knowledge or skill in this area. Sadly, ecological mindfulness movements have frequently got subjugated for political publicity instead of becoming an essential portion of our informative programmes in concept and in practical. "Ecology" is incorrectly understood as a "trend" by everyone, barely comprehending that it is our "realistic condition", and our survival and safety are at a risk. Henry D. Thoreau correctly declares "What's the use of a beautiful house if you don't have a decent planet to put it on?" Although we start now, the repair is predictable in the coming 40-50 years.

The Bombay Natural History Society (BNHS), Mumbai

The BNHS started as a minor group of 6 associates in 1883. It expanded from a small circle of shikaris and individuals from multiple occupations and statues into an imperative study organization that considerably impacts preservation rule in the nation. Its impact on environment strategy structure, study, famous journals and activities of individuals have been an exclusive characteristic of the complex societal communities. Certainly, its main influence has been in the area of environment study. It is an ancient

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preservation of India which is study-based NGO and one that has been at the front of the struggle for protection of breeds and ecologies.

The BNHS issues a famous periodical termed as the *Hornbill* and also a globally popular periodical on *Natural History*. Its furthermore magazines consist of Salim Ali's *Handbook on Birds*, J.C. Daniel's book of *Indian Reptiles*, S.H. Prater's book of *Indian Mammals* and P.V. Bole's book on *Indian Trees*. The most supreme researcher out of all was Dr. Salim Ali, whose ornithological work on the birds of the Indian subcontinent is honored worldwide. Over the years, the BNHS has assisted the administration to set environment-linked rules and has undertaken fights like the 'Save the Silent Valley' movement.

World Wide Fund for Nature-India (WWF-I), New Delhi

The WWF-I was started in 1969 in Mumbai. Later on, the head office were moved to Delhi with numerous subdivision agencies throughout India. The initial years fixated consideration on environment teaching and mindfulness. It undertakes numerous agendas, counting in the Nature Clubs of India Movement for school kids and stands as a research institute and lobby force for ecological and progressive problems.

Center for Science and Environment (CSE), New Delhi

The actions of this Center consist of managing movements, conducting workshops and meetings, and creating ecosystem linked periodicals. It has printed a main article on the State of India's Environment, the primary of its type to be formed as a Citizen's Report on the Environment. The CSE issues a famous periodical too, *Down to Earth* which is a science and environment periodical. It is included in journal of substantial as books, posters, video films and organizes workshops and conferences on biodiversity related issues as well.

1.4 Public Awareness

Environmental deterioration is extensive in the entire world. Hence, more systematic efforts are necessary to develop awareness and expertise about various aspects of pollution. Awareness about environment is necessary to facilitate conservation and regeneration of the environmental resources.

Causes of Ignorance and Absence of Informed Opinion

(a) The common people are mostly not mindful of several ecological difficulties since the conclusions with regards to ecological instruction seldom reaches amongst organizers and the supreme communities of the societal class.

(b) People are hardly able to attend to any social issue under conditions of deprivation of basic needs.

(c) Due to migration from villages to cities, the balance between man's need and the environmental resources breaks down and environmental degradation becomes inevitable.

(d) Our country's schooling organization has mainly proved unsuccessful to link the syllabus with actual difficulties.

Exact Causes for the Unawareness in the Area of Biology and Ecosystem:

(a) Syllabus in medication, production, automation, farming, finances or progression have largely proved unsuccessful to convey information of ecological concerns as a critical subject of their course.

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(b) Individuals who think of environmental progress plans are not skilled or trained to predict the results of their conclusions, which happens to be true in the case of administrators and politicians. Maybe, that's how the insecticide workshop of the Union Carbide got situated so close to a densely inhabited zone in Bhopal.

(c) Occasionally, managers deliberately hide statistics from the common people or misinform them for their selfish publicity. This is understood in situation of the Narmada Valley Project at the current times. Previously, just after freedom, the importance was to upsurge manufacture of foodgrains. Utilization of fertilizers and pesticides was recommended despite its harsh opposing results.

(d) Individuals beginning their personal occupations or manufacturing are directed completely by deliberations of monetary gains for their own. They avoid information regarding ecological alarms because of their uncaring disrespect for the benefits of societal well-being. This happens to be factual in the case of many chemical plants that release their toxins to the nearest water resource like rivers.

Usual Misunderstandings and their Reasons: The extensive unawareness with regards to ecology points misunderstandings and fallacies in this area. Few of them are:

- Sicknesses are triggered by demons or Gods and are not because of contaminations.
- Starvations, famines or inundations are kinds of penalties which God gives for the wrong actions of individuals.
- Rainfall occurs only because of God's love.
- Metropolises are contaminated; however, townships are not. Factually, burning cow dung and wood reasons in fume that is similarly contaminating.
- Metropolises are contaminated due to manufacturing effluents. Factually, the main giver to metropolis's air contamination is vehicle road traffic.
- It is supposed that woodlands are vanishing due to manufacturing and city wants.
- The rising village inhabitants burn maximum wood in the locality by chopping off trees and not considerate to plant again.
- Misunderstandings happen about who is actually accountable. For instance, in the situation of Union Carbide at Bhopal, was it the manufacturer (the business), was it the Administration of Madhya Pradesh, was it the Bhopal Municipal Corporation or is it somebody new to be held responsible? Or everyone is accountable? Many individuals have varied views.

Absence of right information causes misunderstandings. Until informative programmes at all stages don't offer this topic its deserved significance, these misunderstandings will stay.

1.5 Sensitisation and Participation

Methods to Disseminate Environmental Information

Environmental Education

The education for environmental awareness is essential for the younger and older generations. The beneficiaries at the grassroot levels are as much a clientele for environmental education as are the policy or decision-makers and the project

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implementers. Education in India is mainly a state subject and the responsibility is that of the Ministries of Education at the Centre and States.

Objectives of Environmental Education (EE)

To help children and general public towards:

- Awareness, i.e., to acquire sensitivity to the total environment and its allied problems.
- Skill, i.e., to acquire skills for identifying environmental problems.
- Knowledge, i.e., to know conservation of natural resources.
- Evaluation ability, i.e., to evaluate environs measures and education programmes in terms of social, economic, ecological and aesthetic factors.
- Attitude i.e., to acquire set of values leading to concern for environment.
- Participation i.e., to be actively involved and participate in environment issues.

Principles of Environmental Education

- To consider environment in its totality (natural, artificial, technological, ecological, moral, aesthetic, etc.).
- To consider a continuous life process (from pre-school to higher levels as well as non-formal).
- To be interdisciplinary in approach.
- To focus on current and potential environmental situations.
- To emphasize active participation in prevention and solution to problems.
- To examine root cause of environmental degradation.
- To provide an opportunity for making decisions and accepting their consequences.

Environmental Educational Programmes

It involves a three-fold classification of environmental education based on different disciplines.

1. **Environmental Studies:** It is concerned with environmental disturbances and minimization of their impacts through changes in social sciences.
2. **Environmental Science:** It deals with the study of atmosphere, land and oceans. It also deals with cycles that flow through physical and Biological system.
3. **Environmental Engineering:** It involves the study of technical processes used to minimize pollution.

Environmental Education among Children

The environmental scenario of India is very wide indeed. At the first level, special attention must be paid to children. They are to be made aware of health, nutrition, sanitation, hygiene, development/water and food contamination, fodder and fuel wood, etc. NGOs have to play a significant role in environmental education and awareness.

Formal Environmental Education

The spectrum of Environmental Education has four major interrelated components, i.e., awareness, real life situation, conservation and sustainable development.

1. **Primary School Stage:** The attempt is made to sensitize the child about environs. Emphasis should be mostly (75%) on building up awareness,

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followed by real-life situation (20%) and conservation (5%). The contents to be used are surroundings from home to school to outdoor situations. Teaching strategy includes audio-visual and field visits.

2. **Lower Secondary Stage:** At this level, objective must be real-life experience, awareness and problem identification. The quantum of awareness must decrease with increase in real-life situations. The contents are supplemented with general science. Teaching, practicals and field visits are to be done.
3. **Higher Secondary School Stage:** The emphasis must be on conservation, assimilation of knowledge, problem identification and action skills. Contents may be science-based and action-oriented work.
4. **College Stage:** Maximum emphasis should be on knowledge regarding sustainable development based on experience with conservation. The content must be college-based on Science and Technology.

   Teaching practicals and action-oriented field work is to be done. In the school education, NCERT has been playing vital role in designing syllabi, textbooks, guide books, charts, kits, teaching materials and other aids.
5. **University Education:** EE at this level is being looked after by the UGC. There are about 10 universities teaching environmental sciences. The University Education has three major components – teaching, research and extension. At post-graduate level, four major areas are recognized – environmental engineering, conservation and management, environmental health and social ecology.

Non-Formal Environmental Education

This education is designed for any age group, participating in cultural, social and economic development of the country. They form clubs and arrange exhibition, public lectures, meetings and environmental campaigns. Following are the main constituents of this education.

1. **Adult Education:** Adults may influence the society to protect the precious environs by generating posters, slides, audio-visual and information pictures.
2. **Rural Youth and Non-Student Youth:** They may act as volunteers.
3. **Tribals and Forest Dwellers:** They are an important media to protect the forest wealth.
4. **Children Activities:** Department of Environ with the help of United School Organizations of India organized essay competitions among different age group children. Short-term courses are also given by national Museum of Natural History (NMNH) in EE every year. The NMN) conducts spot painting, modeling and poster design about environment for children.
5. **Eco-Development Camps:** A set of a guidelines has been prepared by Department of Environment (1984).

   The objectives are:
   - To create awareness in youth about basic ecological principles.
   - To enable exposure to real-life situations.
   - To acquaint with the conservation needs, problems and efforts.
   - To acquaint with the practice of sustainable development.
6. **Non-Government Organisations:** There are more than 200 NGOs, of which most are involved in EE and awareness, others in pollution control, nature protection and conservation, rural development, waste utilization, wild life

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conservation, floristic and faunal studies, afforestation and social forestry and eco-development.

7. **Public Representatives:** India has environmental forums for MPs and MLAs to discuss environmental problems facing the country. They stimulate public interest for saving the environs.
8. **Training Executives:** Regular courses should be arranged for environmental activities among administrators.
9. **Research and Development Programmes:** Such R&D efforts are supported by DO Environment in Biosphere and Man.
10. **Foundation Courses:** The courses for the probationers selected for the IAS, IFS, IPS and cadets of three wings of Armed Forces need to be supplemented with foundation courses on environment relevant to their area of specialization.
11. **Development of Educational Material and Teaching Aids:** Materials for media (TV, radio, films, newspapers, etc.), audio, mobile exhibitions, audio-visual materials must be operated by competent manpower. One such centre in India is Centre for Environmental Education, Ahmedabad.
12. **Development of Trained Manpower:** Department of Environment (DOE) must organize training programmes for the professors, technical personnel, lecturers and legal experts.
13. **National Environment Awareness Campaign or National Environment Month:** Commencing from 1986, DOE conducts NEAC and NEM. From November 19 to December 18, every year is observed as NEM.
14. **World Environmental Day (WED):** All Governments in the states, UTs, Universities, schools, colleges, academic institutions and voluntary organizations organize suitable activities on WED, i.e., June 5 of each year. DOE supports the function financially.

(A) Major Areas of Environmental Concern

(i) Agricultural productivity
(ii) Land use pattern
(iii) Water resources
(iv) Irrigation pattern
(v) Industries
(vi) Increased waste production and pollution
(vii) Health
(viii) High incidence of disease and malnutrition
(ix) Urbanization.

(B) Other Areas of Concern

(i) Forests
(ii) Woodlands
(iii) Wild life
(iv) Population dynamics
(v) Environmental laws
(vi) Public administration and environment.

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Planning Interventions

Maintaining the quality of life amidst population explosion, increased consumption and waste accumulation calls for disciplined human decisions. Human interventions are inevitable at all levels from the local to the national. These interventions need to be guided by:

(i) Ethics of relationship of men to environment in which the general welfare supersedes self gains and conservation is preferred.

(ii) The direct beneficiaries of the intervention be held responsible for the control of degraded effect and restoration of degraded environment.

(iii) The general public be made conscious from the effects that may result from encroachment on environment and be helped to tackle the problems.

These safeguards are possible only if a multifaceted approach is taken and directed at all strata of society through a hierarchical national network,

1.6 Summary

Environmental studies are multidisciplinary and complex subject. Hence, different aspects must be dealt with all-inclusive approach. There is environmental degradation and systematic overexploitation of natural resources. This can be due to absence of informed opinion or total ignorance. With this in view that there should be proper awareness and knowledge of the subject, it was made compulsory at University level in all Universities in India. Humans as well as all life forms cooperate with their ecosystem. This concept of ecosystem helps us to know the interdependence of living beings and non-living beings, and the flow of energy that keeps the system in equilibrium.

1.7 Check Your Progress

I. Multiple Choice Questions

1. Environment means _____.
   (a) Cover of vegetation
   (b) Hydrosphere on the earth
   (c) Cover of the clouds
   (d) The surrounding made up of biotic and abiotic factors
2. The nature of environmental science or environmental studies is _____.
   (a) beyond our perception
   (b) single disciplinary
   (c) stable
   (d) interdisciplinary
3. Out of the below stated problems, which one is global in nature?
   (a) Soil erosion
   (b) Desertification
   (c) Eruption of a volcano
   (d) Depletion of ozone
4. Environmental problem is created mainly due to _____.
   (a) Ignorance, insensitivity and loss of values toward environment
   (b) Conflict between human groups
   (c) Excessive intake of food

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(d) Technological advancement

5. In an ecosystem, when one organism is dependent on the other, it is called _____.
   (a) Environment
   (b) Living
   (c) Food chain
   (d) Nitrogen cycle

1.8 Questions and Exercises

1. Define environment. Explain its scope and importance.
2. Environment is a multidisciplinary subject.' Discuss.
3. Write a brief note on natural resources.
4. Define ecosystem and explain its classification.

1.9 Key Terms

- **Living Organism:** Any form of life; it includes all plants, bacteria and animals.
- **Population:** Cluster of distinct creatures of the similar breeds existing inside a zone.
- **Food Chain:** The transfer of food energy from its source in plants through a series of organisms where eating and being eaten is repeated.

1.10 Check Your Progress: Answers

I. Multiple Choice Questions

Question	Answer
1	(d)
2	(d)
3	(d)
4	(a)
5	(c)

1.11 Further Reading and References

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Unit II: Natural Resources

Structure:

Objectives

After studying this unit, you should be able to:

- Understand the meaning of natural resources and their over exploitation
- Explain the importance of different movements for environmental protection
- Write about natural disasters like inundations, famines and earthquakes
- Describe the environmental problems such as deforestation, overgrazing, salinity and overuse of fertilisers and pesticides
- Understand the importance of inexhaustible and exhaustible sources of energy

2.1 Introduction

Resource does not denote an object or an element but to the functionality which an object or an element might achieve or to a process in which it might participate namely the purpose or process of achieving a set target like sustaining a want. Supplies, thus, aims to meet ends. The feature of fulfilment is very significant that we contemplate an object or an element supplies for long that it achieves all our demands.

Substances that are needed or utilized to withstand life forms or maintenance is called as resource. It also means resources are entire necessities or creatures, inhabitants and groups that result in buildup of radiation by their amplified obtainability. Nature has offered plentiful supplies to humans and the growth of a nation relies on the supplies available.

For instance, petroleum and several reserves occur in the pre-historic time but they were not assets as humans were not utilizing it. When humans began utilizing it with the development of civilization, they developed into resources.

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Definition

Resource is defined as a form of matter and energy which is essential for the functioning of creatures, inhabitants and ecosystems. Man depends on the resources for his day-to-day living. These resources are air, water, soil, forests, vegetables, milk, fish, animals, energy (fossil fuels and solar power), etc.

Man, himself is an important resource, i.e., human resource his education, skill, knowledge has now been given priority in national policy since it is an index of the development status of a country.

Classification/Types of Natural Resources

Lifespan on earth relies on a huge quantity of factors and facilities offered by mother nature, which are identified as Natural Resources. Therefore, water, air, soil, minerals, coal, forests, crops and wildlife are all examples of natural resources.

The natural resources are of two kinds:

- **Renewable Resources** which are inexhaustive and can be renewed in a stipulated time period, e.g., woodlands, flora and fauna, wind energy, biomass energy, tidal energy, hydropower, etc. Solar energy is also an inexhaustive kind of energy as it is a constantly renewed source of energy.
- **Non-Renewable Resources** that fails to be renewed, e.g., remnant fuels like coal, petroleum, minerals, etc. After they are consumed, these assets won't get restocked.

Our inexhaustive assets, too, can turn into exhaustive sources if we consume them to a degree that their amount of ingestion surpasses their amount of renewal. For instance, if a breed is subjugated so much that its inhabitants' proportions drops below the stage of verge, then they fail to withstand themselves and slowly the breeds turn scarce or non-existent.

It is imperative to guard and preserve our natural assets and utilize them in a sensible way. So, we do not consume them entirely. We must limit the utilization of most of the natural assets. Our utilization should be in a manner that we constantly leave back enough resource supplies for upcoming generations.

Major natural resources are:

(i) Forest resources
(ii) Water resources
(iii) Mineral resources
(iv) Food resources
(v) Energy resources
(vi) Land resources.

2.2 Forest Resources

Woodlands are very significant natural assets on our planet. They cover our planet like a green shield. These woodlands yield countless physical products and offer numerous ecological benefits as well that are vital for life forms.

Woodlands consists of about 30% of the world's land part that comprises surrounded and unrestricted woodlands. Former USSR accounts for about 20% of the world's woodlands, Brazil for about 12%, and Canada and USA each for 6-7%. But the matter of concern still remains that nearly universally the shelter of the natural

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woodlands has deteriorated over time. The highest damage took place in tropical Asia where one-third of the woodland assets have been devastated.

Uses of Forests

Commercial Uses: Woodlands offer us a huge amount of marketable products that consists of timber, firewood, pulpwood, nourishment substances, rubber, resins, non-edible oils, rubber, fibers, lac, bamboo canes, fodder, medicine, drugs and numerous such substances. The entire value projected is to be more than $ 300 billion per year.

Partial portion of the timber chopped off every year is utilized as firewood for heating and cooking. One-third of the timber produce is utilized for construction supplies as lumber, plywood and hardwood, particle board and chipboard. One-sixth of the timber produce is transformed into paste and utilized for paper manufacturing. Numerous woodland areas are utilized for withdrawal of mines, farming, animal graze, and for recreation of dams and their development.

Ecological Uses: Usually, a tree harvests marketable products valued approximately $590. It offers ecological facilities valued closely $196,250.

The environmental facilities offered by our woodlands might be summated up as follows:

- **Production of Oxygen:** The plants give out oxygen by photosynthesis, important for living organisms. They are correctly termed as Earth's lungs.
- **Reducing Global Warming:** The foremost conservatory gas, carbon dioxide (CO_2) is soaked by the woodlands as a raw substance for photosynthesis. Therefore, woodland covering performs as a sink for CO_2, thus dropping the problematic situation of global warming triggered by greenhouse gas, i.e., CO_2.
- **Wildlife Habitat:** Woodlands are the natural habitats of loads of wildlife faunas and floras. About 7 million breeds are originated in the tropical woodlands itself.
- **Regulation of Hydrological Cycle:** Woodland watersheds perform like massive absorbers, soaking the rainwater, reducing the overflow and gradually discharging the water for revival of springs. About 50-80% of the dampness in the air overhead of the tropical woodlands originates from their transpiration which aids in bringing rains.
- **Soil Conservation:** Woodlands hold the soil elements firmly in their roots and avert soil loss. They perform as breeze breakers too.
- **Pollution Moderators:** Woodlands can soak several harmful fumes and assist in purification of air. They have been stated to soak noise and therefore aid in averting both, air and noise effluence.

Overexploitation of Forests

From the time of ancient era, human beings have relied profoundly on woodlands for nutrition, medication, housing, timber and fuel. With rising civilisation, the want for raw materials like timber, pulp, minerals, fuel wood, etc. amplified, which resulted in large-scale logging, mining, road building and clearance of woodlands. Our woodlands help significantly to the country's budget. The global wooden business is valued over US $40 billion per year. Extreme utilization of fuel wood and charcoal, growth of cities, farming and manufacturing zones, and overgrazing have altogether resulted in high exploitation of our woodlands causing their fast deprivation.

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Deforestation

The entire woodland zone of the ecosphere in 1900 was projected to be 7,000 million hectares which was decreased to 2890 million hectares in 1975 and dropped further to only 2,300 million hectares by 2000. Desertification degree is comparatively low in moderate nations, but it is disturbing in tropical nations where it is as high as 40-50% and at the current degree is projected that in the coming 60 years, we would lose more than 90% of our tropical woodlands.

The woodland zone in India appears to have steadied since 1982 with about 0.04% deterioration yearly between 1982-90. FAO (1983) projected that about 1.44 million hectares of land was brought under afforestation during this period which resulted in steadiness. As per FAO estimations, the desertification degree per unit inhabitants in India is the lowermost between the foremost tropical nations, in spite of the statistic that we have a massive inhabitants' proportions and less per capita forest area (0.075 ha per capita). Still, we are faraway the goal of attaining 33% woodland zone, as per our National Forest Policy, as we currently have only 19.27% of our land area (63.38 million hectares) protected by woodlands founded on satellite information (MoEF, 1998).

Major Causes of Deforestation:

(a) Shifting Cultivation: There are a projected 300 million individuals existing as shifting cultivators who practice slash and burn farming, and are founded to clear more than 5 lakh hectares of woodlands for shifting cultivation yearly. In our country, we practice this in North-East regions and to some extent in Andhra Pradesh, Bihar and Madhya Pradesh which gives rise to approximately half of the woodland clearance yearly.

(b) Fuel Requirements: Growing wants for fuel wood by the rising inhabitants in our nation have solely amplified up to 300-500 million tons in 2001 as compared to just 65 million tons at the time of freedom, thus growing the burden on woodlands.

(c) Raw Materials for Industrial Use: Wood for making boxes, furniture, railway sleepers, plywood, match boxes, pulp for paper industry, etc. have applied great burden on woodlands. Plywood is in huge demand for packing tea for tea industry of Assam while Fir tree wood is extremely utilized for packing apples in Jammu & Kashmir.

(d) Development Projects: Enormous devastation of woodland arise for numerous expansion plans such as hydroelectric projects, big dams, road construction, mining, etc.

(e) Growing Food Needs: in emerging nations, the foremost cause for desertification is to fulfil the wants of fast rising inhabitants, farming zones and settlements are formed forever by clearance of woodlands.

(f) Overgrazing: The underprivileged in the tropics mostly depend on timber as a basis of fuel, causing damage of tree cover and the empty regions are converted into graze areas. Overgrazing by the livestock causes additional deprivation of these regions.

Major Consequences of Deforestation: Desertification has extensive penalties, which may be outlined as follows:

(i) The survival of numerous environmental breeds is at a huge risk due to devastation of their natural habitat.

(ii) Biodiversity is vanished and along with that inherited variety is eroded.

(iii) Hydrological cycle gets impacted, thus inducing rainwater.

(iv) Difficulties of soil wearing away and increased infertility of soil.

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Major Activities in Forests

Timber Extraction: Logging for valuable timber, such as teak and mahogany not only includes big trees per hectare but about a dozen more trees since they are powerfully intertwined with each other by vines. Also, street building for creating a road to the trees reasons in additional harm to the woodlands.

Mining: Mining processes for removing reserves and remnant fuels like coal frequently includes massive woodland zones. Pulling out from low deposits is done by **surface mining** while that from bottom-most deposits is done by **sub-surface mining.** More than 80,000 hectares of land of the nation is currently below the pressure of mining actions. Mining and its related actions need elimination of flora along with primary soil layer and covering rock masses. This causes spoiling of the landscape and devastation of the scenery in the zone.

Huge amount of desertification has been informed in Mussoorie and Dehradun valley, because of undiscerning mining of numerous reserves over a length of about 40 kms. The woodland zone has deteriorated at an average rate of 33% and the upsurge in non-forest zone because of mining actions has caused comparatively unbalanced regions resulting into landslips.

Undiscerning mining is in woodlands of Goa since 1961 has devastated more than 50,000 hectares of woodland. Coal mining in Jharia, Raniganj and Singrauli areas have triggered widespread desertification in Jharkhand. Mining of magnesite and soap stones have demolished 14 hectares of woodland in the mountain slopes at Khirakot, Kosi valley, Almora. Mining of radioactive minerals in Kerala, Tamil Nadu and Karnataka are showing same risks of desertification. The enriched woodlands of Western Ghats are experiencing the similar risks because of mining projects for diggings of copper, chromite, bauxite and magnetite.

Dams and their Effects on Forests and People: Big dams and river valley projects have versatile utilizations, and have been mentioned to as “Temples of Modern India”. But these dams are accountable for the devastation of massive zones of woodlands too. Our country has more than 1,550 large dams, the maximum being in the state of Maharashtra (more than 600), trailed by Gujarat (more than 250) and Madhya Pradesh (130). The highest one is *Tehri dam,* on river Bhagirathi in Uttarakhand and the largest in terms of capacity is Bhakra dam on river Satluj in Himachal Pradesh. Big dams have been in sharp attention of numerous ecological clusters worldwide that is primarily due to numerous environmental difficulties counting in desertification and socio- economic difficulties connected to tribal or native people related with them. The *Silent Valley* hydroelectric project was such an individual kind of project which was located in the tropical rainforest part of Western Ghats which involved much concern of the people. *The crusade against the ecological damage and deforestation caused due to Tehri Dam was led by Sunderlal Bahuguna, the leader of Chipko Movement. The cause of Sardar Sarovar Dam related issues has been taken up by the environmental activists Medha Patkar, joined by Arundhati Roy and Baba Amte.*

For constructing big dams, large-scale destruction of woodlands takes place which breaks down the natural environmental steadiness of the area. Inundations, famines and landslips become more predominant in such zones. Woodlands are the sources of precious assets of nature in the way of biodiversity, and by abolishing them (mainly, the tropical rainforests), we are going to damage these breeds even before knowing them. These breeds could have amazing financial or medical worth and desertification causes the damage of such breeds which have grew over millions of years in just one knock.

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Case Studies

1. Sardar Sarovar Dam (Uprooted Forests and Tribals)

The dam is situated on river Narmada and is spread over three states of Gujarat, Maharashtra and Madhya Pradesh. Though the scheme is meant at offering irrigation water, drinking water and electricity to the three states, the ecological effects of the scheme have high thought-provoking queries. A total of 1,44,731 hectares of land will be immersed by the dam, out of which 56,547 ha is woodlands. A total of 573 villages are to be immersed by the Narmada Dam.

Immergence of approximately 40,000 hectares of woodlands underneath Narmada Sagar, 13,800 hectares under Sardar Sarovar and 2,500 hectares under Omkareshwar would additionally form more burden on outstanding woodland zones in connecting zones. Immergence zones are enriched in wildlife, e.g., tigers, panthers, bears, wolves, pangolins, hyenas, jackals, flying squirrels, antelopes, black bucks, chinkara, marsh crocodiles, turtles, etc. Many of these species are listed in Schedules I and II of Wildlife Protection Act, 1972. Therefore, huge damage of these flora and fauna breeds is detained because of the destruction of the woodland under the scheme.

According to the estimations of the Institute of Urban Affairs, New Delhi, the Narmada Valley Project will cause ultimate movement of more than one million people, which is perhaps the major reintegration problem ever come across according to the World Bank. Displacing of the tribals and their compulsory movement in faraway zones might not be effortlessly accustomed to. Besides severe economic deprivation, the displacement will affect tribal peoples' culture, their beliefs, myths and rituals, festivals, songs and dances. These are all closely associated with their environment of hills, forests, and streams of water. Most of these tribals belong to poor, unprivileged schedule castes and tribes who are being uprooted from a place where they have lived for generations. The evacuated individuals have to experience problems and suffering for the sake of growth and wealth of a greater segment of the civilization. It is thus the responsibility of the scheme advocates and administration to pay all-out consideration for correct reintegration of the evacuated tribals.

2. Chipko Movement (Forest)

Perhaps, the first forest movement against indiscriminate cut down of trees was fought in India. The leader of this movement **Amrita Devi** with her 362 followers resisted the chopping of Khejori trees in Jodhpur area. The contractors, with their group of workers, axed the trees to death. Later on, the ruler of Jodhpur banned tree chop down.

Recently, such organized movement was started in December 1972, which has become the famous **Chipko Movement.** A bold woman of **Advani village in Tehri Garhwal district of Uttar Pradesh** had tied the sacred thread round the trees, actually hugged the trees, faced police firing in February 1978 and later courted arrest for this movement. This program sustained under the direction of **S.L. Bahuguna** in various villages. Mr. Bahuguna offered the plans of Chipko Movement for the protection of air, water and soil through a ban on cutting down of trees in the Himalayas at the UNEP meeting held in London in 1982. The movement gives much emphasis on ecological aspects.

What Do the Forests Bear? Soil, Water and Pure Air

Forests are actually the basis of our life. It is in fact a slogan of planting trees for five "Fs"– **Food, fodder, fuel, fiber and fertilizer**. This can make people self-sufficient in all their basic needs. It will generate a self-renewing decentralised and economic

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prosperity, and happiness to mankind. On account of this powerful movement, now the villagers have created an effective non-violent way to stop the devastation by forest industries. When the axe man comes, the people form ring around the trees, they embrace and protect them from death.

In a nutshell, despite of NGO's efforts, there is an alarming situation of grave environmental crisis and ecological disturbances all over the globe on account of population explosion and exceedingly high rate of increased exploitation of natural resources. If this is not arrested, in time it may lead to extinction of more species as well as human race, from planet earth.

Appiko Movement

This movement started in late 1983 in Karnataka. *Appiko* means "to hug". The first Appiko was flashed in September 8, 1983 by the woodland division's chopping of trees in Salkane woodland in Sirsi district. Appiko's goal is to utilize the people's energy to guard and vegetal plants, and to explain the individuals to minimize the utilization of woodland resources. Appiko helpers don't want an entire prohibition on tree chopping. But there should be guidelines and limitations, e.g., local individuals must be referred when trees are marked for cut down.

2.3 Water Resources

Water – A Vital Resource

Water is a vital natural resource, which is essential for multiplicity of purposes. About, 80% (of the total 50,000 million hectares area) of the earth's exterior is protected by water. Out of the estimated 1011 mn km^3 of the total water present on earth, only 33400 m^3 of water is available for drinking, agriculture, domestic, power generation, industrial consumption, transportation and waste disposal. In the biochemical procedure, manufacturing water is utilized as a responsive substance, a solvable, a scrub element and a heat transmission factor. As a base of lifespan for humans, floras and additional life forms cannot be substituted.

Sources of Water

The chief sources of water are rain water, sea water, ground and surface water. In our country, the yearly rainwater is about 400 million hectare meters (MHM).Out of this – 70 MHM of water evaporates immediately, 115 MHM, turns off into surface water bodies and the remaining percolates into the soil. The mass balance of annual rainfall shows that about 70% water is lost by evaporation and transpiration by plants while the remaining 30% goes into the stream flow. Data regarding **ground water resources**, i.e., water obtained from precipitation and stored in aquifers are more limited than those on the surface water resources. Net yearly revival in India is 67 MHM and out of this only 35 MHM is obtainable for utilization. Combined with surface water, it gives the total utilization potential of fresh water to be around 100 MHM. The **potential sources** of water for human use are:

(i) Desalinated sea water or brackish ground water, and

(ii) Reclaimed waste water.

With the speedy development of inhabitants, numerous nations are now utilizing purified sea water as a probable source of drinkable water in shortage affected areas. Purification might be achieved by procedures like concentration, freezing, electrodialysis and reverse osmosis.

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Uses of Water

Water resources are developed primarily for irrigation, domestic use, power generation and industrial use.

Irrigation: The amount of water required for irrigation purposes varies with the climate and the type of crop. Current estimate puts the potential irrigated area around 106 million hectares, i.e., 72 million hectares irrigated by surface water resources and 34 million hectares by ground water resources.

Industrial Water: Industry is much dependent on adequate water supplies. Major industries using water are steel, pulp and paper, chemicals, textiles and petroleum refining industries. A rough estimate indicates that the annual consumption of water by all industries would be between 2-7 and 4-9 MHM by 2005.

Power Generation: More than 99% of water is utilized for condenser cooling in thermal power generation. The total annual withdrawal requirement in the year 2000 was estimated to vary from 3-6 MHM for a low economic growth to 9-3 MHM for a high economic growth.

Domestic Water Supply: An accurate assessment of water required for domestic needs is not possible. Water consumption is about 2% for domestic use. With the growing population, the demand for fresh water is steadily increasing in India. But the availability of good quality water is dwindling because of misuse, waste and pollution.

Requirement of Fresh Water in India

Agriculture sector is the major consumer of water. It is followed by domestic needs, thermal power generation and industries (Table 2.1). By 2005, the total water requirement is expected to increase 3 times as much as we had in 1974. The industrial sector will require about 20 times and power generation sector about 15 times more water than it was in 1974.

Floods

Flood refers to a situation when the limits of river channel, i.e., the natural level fails to contain the entire flow of the river water and the water inundates the land along with the river channel. Floods are more common in tropical and sub-tropical regions.

Table 2.1: Estimates of Water Requirements in India

Water Needed for	1974	2000	2025
Irrigation	3500	6300	7700
Thermal power generation	110	600	1600
Industries	55	300	1200
Domestic needs	8-8	26-6	390
Livestock management	47	7-4	110
Total	3800	7540	11000

All quantities are in cubic kilo metres.

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Causes of Floods

1. Natural Causes

- The natural factors which cause river floods are prolonged high intensity monsoon rainfall.
- In the snow-fed rivers of North India, snow melting due to global warming has excessively increased the water level of streams causing them to flood.
- Unexpected alterations in channel gradient at the intervening zones of foothill slopes of the mountains is cause for stream inundations too.
- Hindering of unrestricted movement of the streams due to huge wreckages caused due to landslides results in run-off of stream water.
- Inundations take place because of lava flareups too. The extreme cyclonical hurricane yielded heavy rainfall between September 26 to 29, 1978 totaling to 600 mm in the Damodar river. High intensity rainfall increased the water level to about 2500 mm in the plain area and 5000 mm in the mountainous regions in Assam which caused frequent floods of high magnitude through the Brahmaputra river.
- The natural causes of flood also include the cyclones and flash floods, resulting to destruction. Substantial amount of rainwater in the arid and semi-arid regions, where the rainfall is generally scant, low and infrequent, causes flash floods in rivers. Such rivers are incapable to lodge massive volume of water due to poor natural drainage systems. For example, unprecedented rainstorms in Jaipur city (Rajasthan), India in 1981 caused flash floods and raised the level to 836.4 mm in rivers.
- Hindering of usual movement of the streams by landslides triggered by earthquakes causes unexpected extreme flash inundations in the downriver.

2. Anthropogenic Causes

- Desertification in a huge amount in the higher catchments of foremost streams causes extreme movement of water to the grasslands resulting in inundations.
- Sedimentation is the foremost cause for inundating in Brahmaputra stream. Amplified exterior overflow also speeds up the process of mud wearing away and sediment load of the rivers. It causes siltation of riverbeds and filling of the valleys.
- Man-made activities such as building construction, urbanization, channel manipulation through diversion of river course, construction of bridges, reservoirs, etc. cause devastating floods in rivers.
- Accumulation of wastes, sewage and garbage, filling of urban drains, gradual encroachment of human settlements near the channels and construction of roads are the significant factors causing river floods.
- The riverine cities like Kanpur, Varanasi and Allahabad in India, located along the mighty Ganga river are the burning examples of ecological degradation caused by recurrent floods of the Ganga river.

Floods in India

Maximum of the inundation susceptible zones of the nation are situated in the northern portions primarily in the Ganga grasslands of the states of Uttar Pradesh, Bihar and West Bengal. Stream inundations are responsible for 65% of the entire harm to the nation. The total area subjected to flood has doubled from 20 million hectares in 1991 to

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40 million hectares in 2001. Today, there is a continuous growth in the frequency, intensity, dimensions and magnitude of damages done by river floods.

Main Flood Zones in India

1. Rivers of Himalayas comprising the Ganga, Brahmaputra and their tributaries.
2. The north western river of basin comprising of the rivers Ravi, Jhelum, Chenab, Sutlej and Beas.
3. The central India and Peninsula river basins consisting of Godavari, Kaveri, Tapti, Narmada, Chambal, Krishna and Mahanadi.

Areas located around these rivers particularly North Bihar, Eastern Uttar Pradesh, Punjab, Haryana and North-East Rajasthan account for 90% of the total flood change. The main reasons of floods in these areas are due to heavy precipitation (more than 15 cms in a day), hurricanes along with powerful breezes, increasing of waterbeds, dropping of streams over natural banks, indiscriminate deforestation and inadequate drainage systems in irrigated areas.

Flood Forecasting

Flood forecasting offers one of the most cost-effective methods of flood management.

Preparation of Forecast

Typically, the forecast is prepared on the basis of the daily water level of river or its tributary as observed at a specified time in the morning at all the monitoring stations. Establishing the rainfall run-off relationship and construction of hydrographs, stream flow routing and flood stage development are the major steps, and today, satellites like **IRS-IB and INSATs** predict accurate flood forecasting.

Flood Forecasting Stations

The Central Water Commission set up the first flood forecasting station in India in 1959. Today, it has a network of 187 forecasting stations which issue about 6500 flood forecasts annually. Bihar has the largest number of forecasting stations, i.e., 36 followed by 33 in Uttar Pradesh, 23 in Assam, 14 in West Bengal, 11 each in Andhra Pradesh and Orissa, 10 in Gujarat, 7 in Maharashtra, 4 in Karnataka, 3 in Madhya Pradesh, 2 each in Delhi, Dadra & Nagar Haveli and 1 in Haryana.

Flash Floods

Flash floods are generally caused by **cloud bursts** during the monsoon. These are highly localized phenomenon. For instance, when the whole country was reeling under drought in 1979, there was a flash flood in the Luni basin of Rajasthan. Similarly, in early June 1990, there were cloud bursts in South-West Rajasthan.

Effects of Floods

- In India, about 40 million hectares, i.e., approximately $1/8^{th}$ of the country's geographical area is flood prone. Annually, about 8 million hectares of total area get severely damaged by floods.
- Floods are among the most destructive phenomenon of nature. Worldwide flood damage to agriculture, buildings and public utilities account to billions of dollars every year along with the loss of precious human and animal lives.

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- Floods damage about 3.5 million hectares of vegetation cover. The severely affected cropped soil was as high as 10 million hectares in previous years.
- The maximum flood damage loss was estimated at ₹ 21 crores in 1951. It was ₹ 4,060 crores in 1995.
- Recently, the Planning Commission has reported that ₹ 2,500 crores have been utilised in inundation regulation plans. The money was used to construct new embarkments, drainage channels and afforestation.
- Flood affects the micro-environments in low lying areas. It causes damage to vegetation, output in totaling to downfall of houses, roads, bridges and inundation of low-lying areas.
- Sheet erosion of soil takes place due to flash floods. This sediment load in rivers causes their water level to rise disrupting the aquatic life.
- Flash floods generally revitalise the dead drainage system, so that the streams become very active. The area cultivated in the beds of buried drainage system get inundated.
- Sand casting occurs due to flash floods. There will be considerable cuts in the existing drain owing to the high velocity of the activated streams.

Flood Control Measures

1. **Non-Structural Measures:** Non-structural measures can effectively tackle the problem of floods. Physical control methods like embankment, dams and drain channels cannot provide protection to all the flood-prone areas of the country. It is crucial to accept non-structural procedures to alleviate the dangerous effect of inundations. Once a dam is built, people believe that the river is completely controlled. But when a flood occurs, the nearby people suffer more damage than what they would have suffered had the structure not been built there.
2. **Flood Forecasting:** Inundation prediction and primary cautionary to affected areas are among the most important and cost-effective means to reduce the impact of floods.
3. **Flood Plain Zoning:** The purpose of inundation plain zoning is to control the land utilized in the inundation susceptible zones so as to limit the harm by inundations. Flood plain zoning, therefore, aims at determining the locations and the extent of areas expected to be spoiled by inundations. It also advances zones in a way that the loss in the event of floods is reduced to be minimum.
4. **Flood-Proofing Measures:** These measures include location and construction of industries, public utilities, telephone exchange, electricity installations, railway stations, aerodromes and commercial centres above the observed flood levels so that they may remain unaffected in the event of flood.

   The services of scientific and technological institution, financial authorities, industrial enterprise and non-governmental organizations should be utilized in the activities for mitigation of flood hazards.
5. **Flood Risk Maps:** It is possible to demarcate the zones for different flood frequencies with the help of data and maps. Maps can predict the areas liable to be affected at different water levels integrated long-term plan in conjunction with plans for other water resource development like irrigation, power and domestic water supply. Recently, the Central Government has set up the Ganga Flood Control Commission and the Brahmaputra Board for Flood Control.

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Other Control Measures

- Floods can be controlled by large-scale afforestation in the hilly areas. It will encourage more infiltration of rain water and can reduce the sediment load of river.
- Meander loops and bends in the highly sinuous rivers can retard the quick disposal of water.
- Storage reservoirs can be used to control the flood. Such reservoirs were constructed on Miami river in the state of Ohio, USA. Besides flood control, the Damodar Valley Corporation in India generates hydroelectricity and provides water for irrigational purposes.
- Flood diversion systems may reduce the flood magnitude.
- Floods can be controlled by constructing channels, ridges and artificial embankments.

Flood Protection Works

The extent of flood damage can be reduced by adopting following protection works:

- Embankments, flood walls and ring bunds should be aimed at protection against inundation.
- Channel improvements (by dredging), run-offs and detention basins to reduce flood levels.
- Watershed management to decrease the run-off.
- Raising levels of habitations.
- To prepare flood control master plans for various basins.
- Advance flood warning and emergency evacuation.

Drought

Drought is an insidious phenomenon which creeps over an extensive area. According to Indian Meteorological Department (IND), drought is defined as *a situation when the mean annual rainfall is less than 75% of the normal rainfall and there is shortage of surface or ground water affecting plant life adversely.* Severe drought occurs when the shortage of rainwater surpasses 50% of the usual rainwater for 21 days or more. Although rainfall is the main parameter for the determination of drought, yet other drought indicators may be used which include evaporation, humidity, wind, air temperature, solar radiation, soil moisture, stream flow and plant conditions. Drought thus indicates **dryness or want of water.** As the total rainfall decreases, the tendency to both spatial and temporal variation in rainfall increases.

Drought Prone Areas: Using the annual and South-West Monsoon rainfall data (for 1940 to 2000), the Irrigation Commissions (2000) has identified certain drought and chronic drought areas as those with a rainfall of less than 10 cms where 75% of this rainfall is not received by land and where irrigation is less than 30% of the cropped area. The Commission identified Rajasthan, Gujarat and adjoining parts of Punjab, Haryana, west of Madhya Pradesh and west of Uttar Pradesh as drought-prone areas. It pointed at western Rajasthan and Kutch as chronically affected areas. The World Bank reported 60 million hectares (mha) in about 72 districts as drought-prone in India. Some of the acute drought-affected areas are described below:

1. **Bellary Region.** In the Bellary region of north interior Karnataka, the rainfall is as low as 508 mm. In the high rainfall (> 1000 mm) region of Assam and Meghalaya, drought could be apparent in 15 years.

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2. **Sahel Region.** The region extending between Sahara and Savanna region and running from Africa through Senegal, Mali, upper Volta, Niger, Nigeria, Chad, Uganda and Ethiopia is known as Sahel or sub-Sahara region. The drought zone of the Sahel is a tropical grassland and is characterized by a feast climate. Prolonged drought results in the depletion of ground water and hence acute scarcity of drinking water. The cumulative effects of drought in 1975, 1980 and 1988 became so disastrous that it became a Human Catastrophe. This drought resulted in drying of wells and loss of lives. Thousands of people died of hunger, starvation, thirst and diseases.
3. **Australia.** The recent dry spells in Australia were observed in 1992 and 1998 which caused decrease in the farm gross national product by 20%. The opposing effects of drought included huge fall in cattle number and loss of vegetation. Enormous dust storms submerged many fences under thick layer of sands. The city of Melbourne and railway lines were buried under dense deposits of dust on November 21, 1992.
4. **India.** Since monsoon climate and associated rainfall is very much deceptive and uncertain, maximum regions of the nation are affected by droughts and floods. For instance, Rajasthan is a highly drought-prone area but heavy rainfall 500 mm a day in July 1990 caused severe floods in Rajasthan. The most drought-affected areas of India are divided into three zones, viz.,
   (i) Desert and semi-arid regions spread over an area of 600,000 kms and stretches from Ahmedabad to Kanpur. The yearly rainwater arrays from 350 mm to 750 mm.
   (ii) This zone is situated to the east of the western Ghats and extends to 300 km covering 370,000 km^2 of area. It includes south-western Andhra Pradesh, Karnataka and south-western Maharashtra. The rainfall is highly inconsistent and less than 750 mm. From 1984 to 1987, there were consecutive drought in this zone.
   (iii) Drought occurs in some scattered pockets of Tirunelveli district located south to Vagai river. Coimbatore, Palamau of Bihar and Kalahandi region of Orissa are also highly affected by drought.
5. **UK.** In UK, less than 60% precipitation occurred from May 1, 1975 to April 30, 1976. This dry spell caused severe scarcity of water for domestic and industrial purposes. The total loss to vegetation amounted to more than 500 million pounds.

Impacts of Drought

Drought affects all types of life-forms in the ecosystem as follows:

- Acute shortage of drinking water.
- Loss of standing crops.
- Sensitive species of plants vanish on account of adverse drought conditions.
- Scarcity of food, fodder and fuel.
- Migration of animals to other places.
- Lack of employment.
- Adverse effects on agro-based industries.
- Acute effects on hydel power generation.
- Increase in imports, etc.

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There are few longstanding steps to efficiently manage the harshness of famine.

- Utilisation of water from all sources, i.e., rainwater, exterior and underground water.
- Building of tanks, ponds, reservoirs and wells to offer irrigation services.
- Coating of waterways and distributaries to minimize water losses.
- Introduction of crop pattern that would offer best safety from famine and safeguard a sensible and dependable revenue per hectare.
- To present the parched agricultural methods.
- Introduction of water preservation arrangements.
- Expansion of gardening and meadow lands.
- Speedy accomplishment of ongoing schemes.

A Drought Prone Area Program (DPAP) was launched in 1998 in arid and semi-arid regions with deprived natural supplies grants. The aim was to promote more productive dryland agriculture by better soil and moisture conservation, scientific use of water sources, afforestation, livestock development and to restore ecological balance. The Tenth Five Year Plan puts stress on the training of project staff at the district level for preparation of plans, creating awareness among the people and developing effective cooperation between agricultural research agencies for effective transfer of technology. It emphasizes on the ensured participation of the people in planning and implementation of the program.

Dam – Benefits and Problems

Benefits: In India, where 75% of the population depends on agriculture, the execution of **River Valley Projects** (RVP) and dam building are the important steps of growth strategy. Our country has the biggest RVPs in the world. About 1,850 major dams have been built by the year 1999 at the cost of ₹ 25,026 crores. They cover about 2% of India's total land area.

Effects of Dams on Woodlands and Rural Individuals: Although dams provide several benefits, but the people have to pay their heavy cost.

- Dams have cut out beautiful stretches of rivers, forests, farmlands, wildlife habitat and areas of geological significance.
- Ecological factors are also affected because sediments rich in nutrients settle in the reservoir.
- The reservoir behind the Aswan high dam in Egypt has caused spread of a parasitic worm which caused a devastating disease. Further, the increase in humidity is causing rapid deterioration in monuments.
- Destructive earthquakes observed near Koyana are attributed to Koyana Dam in Maharashtra, India.
- The biggest economic and environmental cost of the RVPs is the immergence of big areas of residences, roads, railways, etc. **Narmada RVP** will submerge 23 kms of railway, 85 kms of roads, 45 kms of telephone lines, 10,000 buildings and 3,310 drinking wells. **Narmada RVP**, perhaps the **largest in the world** is expected to cost ₹ 25,000 crores. It is a chain of 30 big and about 3,000 smaller dams spanning the states of Maharashtra, Gujarat, Madhya Pradesh and Rajasthan. It is expected to irrigate 1-23 lakh hectare and generate 1000 MW of power. The dam system will submerge 91,350 hectares. Of these, 40,325 hectares is forest. About 1-5 lakh people were affected severely and 30,000 tribals were displaced.

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Table 2.2: Indian River Valley Projects

Sr. No.	Projects	River	Purpose	Location	Benefits to States
1	Bhakra Dam	Satluj	Irrigation and hydel power	Near village Bhakra, Bilaspur District, HP	A joint venture of Punjab, Haryana and Rajasthan. Benefits (power) to Delhi and HP also. Govind Sagar reservoir.
2	Hirakud Dam	Mahanadi	Irrigation, hydel power and flood control	Hirakud, Sambalpur District, Orissa	Orissa project, world's longest dam (4801 m long).
3	Nagarjuna Sagar Dam	Krishna	Irrigation and hydel power	Nandi Konda village, District, Nalgonda, AP	Serving mainly Andhra Pradesh.
4	Tungabhadra Dam	Tungabhadra, a tributary of river Krishna	Irrigation and hydel power	Near Hospet town in Karnataka	A joint project of AP and Karnataka.
5	Kosi Project	Kosi, a tributary of river Ganga	Irrigation, power and flood control	The barrage on river Cosi near Hanumannagar in Nepal (Indo-Nepal border)	Serving mainly Bihar but Nepal also gets power.
6	Damodar Valley Project	Damodar, Hugli	Irrigation, power and flood control	All dams lie in Bihar but Durgapur Barrage is in West Bengal	Serving both Bihar and West Bengal. Irrigation of navigation and flood control in West Bengal only.
7	The Chambal Valley Project,	Chambal, a tributary of river Yamuna	Irrigation and power	Gandhi Sagar (MP), Rana Pratap Sagar, Jawahar Sagar and Kota Barrage in Rajasthan	Serving both MP and Rajasthan. MP has one dam and the rest are in Rajasthan.
8	Rihand Dam	Rihand, a tributary of river Son	Hydro power	At Pipri, Mirzapur District (UP)	It is mainly a hydro power project, serving largely UP and the adjoining areas.
9	Mettur Dam	Kaveri	Irrigation and hydel power	In Tamil Nadu	Very old river valley project serving the State (Kaveri is the world's best utilized river).
10	Mayurakshi Project	Mayurakshi, a tributary of Hugli	Irrigation, hydel power and flood control	In West Bengal	Serving in West Bengal mainly.
11	Rajasthan	From river Satluj	Irrigation	Taking off from	Irrigation in

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	Canal Project			river Satluj at Harike, runs through Punjab, Haryana and Rajasthan	Rajasthan only, Ganganagar District and getting maximum benefits. Punjab and Haryana have only the feeder section of Feeder canal.
12	Sharavati Hydro Project	Sharavati, a short westward flowing river	Hydel power	Amassing Jog Falls in Karnataka	One of the largest hydel power projects in the country, serving mainly Karnataka.

It has been estimated annual rate of sedimentation in India is 8.51 million hectares 100 sq. kms. This causes reduction of both the capacity of the dam to hold back heavy flood waters as well as its irrigation potentials. **Siltation** has been observed to decrease the capacity of the dams by 20% per year resulting in the reduction of their economic life. As a result, the life span of one of the projects (Ramganga), originally estimated to be 150 years, is expected to be reduced to 45 years.

The famous **Chilika Lake** in **Odisha**, the Asia's biggest saline water lagoon is under threat. Rapid deforestation and absence of any conservation programmes are the most important reasons for the rapid siltation of this beautiful lake. As a result of siltation, the **Bay of Bengal** is degrading at the rate of 1.4 km^2 per year. Its original configuration of 2200 km^2 has now reduced to only 916 km^2.

The **Sukhna Lake** near Chandigarh too is experiencing a similar destiny. It was completed in **1985** and then became an ideal wetland with a diversity of plants and animals. Intake of silt per hectare was 141 metric tons per hectare. Its water retention capacity was excessively decreased by 1987 and water storage capacity reduced from 1974 ha metres to 389 ha metres in this period. By **1988**, one could walk across during the summer. By the efforts of voluntary organizations, NCC, NSS and Chandigarh administration, the lake was restored in **1989**.

Conflicts over Water

Indispensability of water and its unequal distribution has often led to inter-state or international disputes. Problems linked to allotment of stream water have been mainly upsetting our farmers and also trembling our administrations. Few foremost water fights are conversed here.

1. **Water Conflict in the Middle East:** Three river basins, namely the Jordan, the Tigris-Euphrates and the Nile are the common water resources for Middle Eastern countries. Ethiopia controls the head waters of 80% of Nile's movement and strategizes to upsurge it. Sudan attempts to distract additional water as well. This would severely impact Egypt, which is a desert, except for a thin strip of irrigated cropland along the river Nile and its delta. The inhabitants of Egypt are probable to duple in the coming 20 years, thus growing its water disaster. Similarly, there is a violent fight for water among Jordan, Syria and Israel for the Jordan River water share.

   Turkey has abundant water and plans to build 22 dams on Tigris-Euphrates for Hydroelectric power generation. But it would severely decrease the movement of water to Syria and Iraq, lying downstream. Turkey dreams to become the region's water super power. It strategizes to send and trade water

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to starved Saudi Arabia, Kuwait, Syria, Israel and Jordan. Probably, the next war in the Middle East would be fought over water and not oil.

2. **The Indus Water Treaty.** The Indus, one of the mightiest rivers, is dying a slow death due to dams and barrages that have been built higher up on the river. The Sukkur Barrage (1932), Ghulam Mohamad Barrage at Kotri (1958) and Tarbela and Chasma Dams on Jhelum, a tributary of Indus has caused extreme decrease of the Indus delta. In 1960, the Indus water treaty was established vide which Indus, the Jhelum and the Chenab were allocated to Pakistan and the Satluj, the Ravi and the Beas were allocated to India. Being the riparian state, India has proactive authority to build embankments surrounding all these rivers in Indian territory. Still, the agreement needs that the three rivers assigned to Pakistan might be utilized for *non-consumptive* purposes by India, i.e., without altering its movement and quality. With progressing political relations amongst the two nations, it is necessary to implement techno-economic specifics and go for a combined growth of the river sink in a maintainable way.
3. **The Kaveri Water Dispute:** Out of India's 18 major rivers, 17 are split amongst various states. In the entire situations, there are powerful battles over these natural assets which barely appear to settle. The Kaveri river water is a main cause of argument between Tamil Nadu and Karnataka, and the battle is nearly a hundred years old. Tamil Nadu, inhabiting the downriver area of the stream desires water-use controlled in the upriver. However, the upriver state Karnataka declines to do so and entitles its preeminence over the river as upstream user. The river water is nearly entirely utilized and both the states have growing strains for farming and manufacturing. The consumption is more in Tamil Nadu than Karnataka where the catchment area is rockier. On June 2, 1990, the Kaveri Water Dispute Tribunal was set up which through an interim award directed Karnataka to ensure that 205 TMCF of water was made accessible in Tamil Nadu's Mettur dam every year, till a settlement was reached. In 1991-92 due to good monsoon, there was no dispute due to good stock of water in Mettur, but in 1995, the condition twisted into a disaster because of late rainfalls and an expert committee was set up to look into the matter which found that there was a complex cropping pattern in Kaveri basin. *Sambra* paddy in winter, *Kurvai* paddy in summer and some cash crops required rigorous water, thus aggravating the water crisis. Correct choice of crop diversities, best utilization of water, improved limiting, balanced distribution forms, and evaluating of water are recommended as few ways to resolve the issue.
4. **The Satluj-Yamuna Link (SYL) Canal Dispute:** The issue of sharing the Ravi-Beas waters and SYL issue between Punjab and Haryana is debated repeatedly and the case is in the Supreme Court. The Eradi Tribunal (1985) grounded the distribution of water on the basis of the time inflow data of 20 years (1960-80), according to which 17.17 MAF (million-acre feet) water was obtainable. Though today, it is claimed by Punjab that in the last 17 years there has been steady deterioration dropping the amount to 14.34 MAF. The Supreme Court on January 15, 2002 directed Punjab to complete and commission the SYL within a year, failing which the Center was told to complete it. However, two years have passed, but neither the SYL has been completed nor the conflict over sharing of Ravi-Beas water is resolved.

   The battle is that Punjab being the riparian state for Beas, Ravi and Satluj stakes its claim, Haryana has met severe scarcity of water after it became a

state in 1966 and has been trying to help it out by signing an MOU (Memorandum of Understanding) with Uttar Pradesh, Rajasthan and Delhi for allocation of Yamuna waters. The Yamuna basin covers the state of Haryana while the Indus basin covers Punjab. The battle rotating about distribution of stream water requires to be undertaken with better consideration and impartiality.

Traditional Water Management System

In our nation currently, there are numerous townships where water administration is done by local administrators but not by the Irrigation Department. In South India, a *neerkatti* manages the traditional tanks a lot professionally grounded on his/her information of the terrain, drainage and irrigation needs. They typically choose to the tail-end fields and decide per capita distribution of water grounded on the storage of obtainable water in the tank and crop needs. In Maharashtra, the water managers are called ***havaldars*** or ***jaghyas*** who succeed and settle battles by supervising the water channels from main canal to the distributary canals. In Ladakh, the water manager is known as ***churpun*** who has got complete charge with full powers over distribution of obtainable water. The main base of water is melted water from glaciers and snow accompanied by water from springs and marshes. The water is circulated to various arenas through a complex system of earthen channels.

In traditional water management, advanced measures ensure unbiased circulation of water, which are popularly applied. The 'gram sabhas' favor these strategies openly. While water arguments amongst states and countries frequently accept fights like conditions, our traditional water managers in villages prove to be quite effective.

Big Dams: Benefits and Problems – Case Study

Benefits

River-valley schemes with big dams have typically been contemplated to perform as an important role in the growth procedure because of their numerous utilizations. Our country holds a better position of having the biggest number of river-valley schemes. These dams are frequently observed as a sign of nationwide progress. The tribals living in the area pin big hopes on these projects as they intention at offering jobs and uplifting the standard and quality of life. The dams have incredible possibility for financial development and evolution. They can aid in inspection of inundations and scarcities, produce electrical energy and decrease water and power scarcity, offer irrigation water to inferior zones, deliver drinkable water in distant parts and encourage triangulation, fishery, etc.

Environmental Problems

The ecological effects of big dams are numerous because of which frequently the big dams convert into a topic of disagreement. The effects can be at the upriver as well as downriver levels.

(A) The upriver complications consist of the following:

(i) Movement of tribal people.

(ii) Damage of woodlands, plants and animals.

(iii) Variations in fisheries and the depositing lands.

(iv) Siltation and deposit of artificial lake.

(v) Damage of non-woodland property.

(vi) Sluggishness and water logging nearby the artificial lake.

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(vii) Breeding of vectors and spread of vector-borne diseases.
(viii) Reservoir Induced Seismicity (RIS) triggering earthquakes.
(ix) Development of water wildflowers.
(x) Micro-climatic variations.

(B) The downriver effects consist of the following:
(i) Water logging and saltiness because of over irrigation.
(ii) Micro-climatic variations.
(iii) Decreased waterflow and silt deposition in river.
(iv) Flash inundations.
(v) Salt water interruption at river mouth.
(vi) Damage of property fruitfulness along the banks of river since the sediments carrying nutrients get deposited in the reservoir.
(vii) Eruption of vector-borne diseases like malaria.

Thus, dams are constructed to help the social order with numerous utilizations, but it has quite a few severe side-effects. That is why, today, there is a change in the direction of building small dams or mini-hydel projects.

2.4 Mineral Resources

Introduction

The, term **mineral resource** refers to an extensive diversity of resources gained from earth. Human welfare and availability of mineral resources have been closely linked together. The nation's complete success rests mainly upon the source of inorganic goods.

Categories of Minerals

1. **Metallic Minerals:** Reserves when treated offer metals such as copper, zinc, iron, aluminium, etc.
2. **Non-metallic Minerals:** Minerals yield products other than metals such as phosphate rocks, clay, sand, stones, soda ash and various salts. Coal, oil and natural gas which provide energy are also included in this category.

Formation of Mineral Deposits

Maximum of the reserves or their disintegration goods are broadly spread in the earth's crust. Inorganic deposits are created by gradual biological or geo-chemical procedures which may be summed as follows:

- Concentration of reserves at the time of freezing of melted rock resources.
- Creation of inorganic deposits by desertion of sea water and oxidation-reduction reaction.
- Concentration of reserves through withstanding, transportation and sedimentation.
- Creation of inorganic deposits by bacterial actions.

Consumption (Use) of Mineral Resources

Copper, silver, gold, iron, manganese, chromium, nickel, etc. can be extracted from their ores and utilized by man. The widespread availability of iron minerals made it possible for the metal to be used tremendously. A little amount of carbon is added to

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iron to produce steel. Initially, trees were cut to produce charcoal (coal). As steel production expanded, much of the forests had to be cut down to be turned into coal required for steel manufacture. The upsurge in steel manufacture was coordinated by a similarly fast increase in its utilization. By 1965, per capita steel utilization had touched to 625 kg per person per year in advanced nations. The universal average per capita steel utilization was approximately 240 kg per person yearly in 1995. Consumption of copper, zinc, lead, etc. has remained remarkably constant over the last fifty years while those of tin, nickel, manganese, etc. has decreased as compared to total steel consumption. Nowadays, the entire amount of all metal and non-metal resources gained from earth sums up to 180 billion tons. This states that to sustain one person in technically progressive culture having an inhabitant of 5 billion people, we have to dig up about 50 tons of resources from earth's crust. Clearly, humans have become an imperative geologic force. Main share of biosphere's inorganic properties is still being consumed by the wealthy and technologically advanced countries. Per capita request of resources of underprivileged nations is growing speedily triggering great stress on the inorganic possessions of the ecosphere.

Consequences of Overexploitation of Mineral Resources

The result of extreme utilization of inorganic resources are severe which might harm the whole environment.

- **Rapid Depletion of High-Grade Mineral Deposits:** The ever-rising demand of minerals will compel miners to carry on the extraction from lower grade of deposits which possess a little percentage of the metal. For example, copper was extracted from ores containing 8-10% of metal content about 500 years ago. But now, we are using deposits which contain only 0-35% of copper. To produce one ton of copper metal, one has to dig out 285 tons of ore. This will include a big quantity of radiation outflow and a huge amount of waste substances too. Maximum of the metallic elements are existing in extremely spread-out manner in the soil, rocks, trash or waste products. Now, the requirements can be fulfilled by employing a sophisticated technique, but the cost would be heavy, causing metals to become more expensive.
- **Wastage and Dissemination of Mineral Wealth:** Maximum of our inorganic deposits arise as a multifaceted combination of an amount of inorganic essentials. After elimination of topmost soil, we excavate out the required sum of minerals, keeping behind others as a leftover matter. Removal of single component typically sprinkles the other essentials which are less in source. Worldwide smelting of minerals for extraction of metals releases enormous quantity of sulphur and heavy metals such as Hg, Cd, Ni, As, Pb, Zn, etc. into the environment deteriorating the quality of soil and water. However, mining industries can extract metals by applying advanced technology without excavating fresh deposits.
- **Contamination Triggered by Hefty Radiation Necessity of Mining Industry:** Massive quantity of radiation is mandatory for the elimination of sand, silt, clay, concentration of ore, smelting and refining operations, electrolytic processes, disposal of solid, liquid wastes or tailings, transportation of solid wastes and finished products, etc. The energy required for these purposes comes from diverse sources which include firewood, coal, petroleum, natural gas and electricity. These energy sources, when burnt, liberate several gaseous (e.g., NO_2, SO_2, CO, CO_2, etc.) toxins in the atmosphere.

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Mining and Processing Wastes

Mining has formed few of the major ecological tragedy regions globally. The removal and processing of reserves usually comprises of subsequent stages.

1. The soil and rock covering the inorganic deposits has to be detached before real mining processes begin.
2. The mineral is then excavated and crumpled.
3. The crushed mineral is run through concentrators to eliminate scums.
4. Concentrated mineral is compacted to crude metal which is then refined to pure state as open cast mining does.

In 1988, the top soil overlying mineral deposits in USA amounted to 3.3 billion tons of matter removed. This material clogs streams and gets deposited in water bodies. Since most of the ores contain large amount of Sulphur, its oxidation and leaching results in the formation of acidic leachates (water containing dilute Sulphuric acid). Leachates contain appreciable amount of heavy toxic metals, which deteriorates water quality.

The ranking of mineral is significant in defining the complete effect of removal action. A mineral comprising 20% of metallic content produces 4r tons of tailings per ton of metal removed, but a cheap mineral comprising 1% of metal generate 99 tons of tailing per ton of metal obtained. **Gold mining** is seriously damaging as the metal content of gold deposits is expressed in ppm. Miners at Gold Strike Mine in Nevada, the largest in USA, extract 325,000 tons of ore to produce about 50 kg of gold per year. It results in extreme damage of soil nutrients.

In Amazon basin, Brazil, miners use hydraulic mining which involves blasting of gold bearing hillside with high pressure stream of water followed by sending the sediments through channels where gold being heavier settles down from tons of non-valuable material. This deposit and residues are lastly eroded down into few nearby rivers. Mine workers emit nearly 100 tons of mercury into the Amazon river annually while trapping gold from sediments.

Heap leaching technique is used in North America to extract gold from an extremely cheap quality of minerals. The procedure comprises of using cyanide solution to sprinkle over a pile of substandard minerals. Cyanide solution tanks and polluted tailings, both, remain after the gold withdrawal. These create dangers to exterior rainwaters and underground aquifers. In October 1998, about 45 million litres of cyanide solution from a tank at **Brewer Gold Mine**, South Carolina, dropped over into a stream of local Lynch river, slaughtering 10,000 marine life-forms and even more. The poisonous water also causes risks to wildlife flora and fauna.

Conservation of Mineral Resources – Case Study

Following steps may be adopted to conserves mineral resources:

1. Economy in the use of mineral resources.
2. Making finished products to last longer.
3. Use of less precious substitutes.
4. Renovation, recycling and reuse of metals.
5. Applying effective techniques to recover materials from minerals.
6. Search of new earth's treasures.
7. Protection of existing mineral deposits.

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Mineral Resources of India

Iron minerals which are the most important ingredient of today's economy are found in sufficient quantity in India. The iron ore production has raised from a meagre 3 million tons in 1950 to 85 million tons in 2003.

Aluminium reserves in India have been estimated to about 2650 million tons including 1890 million tons of rich metallurgical grade. Production of aluminium increased from 4,000 tons in 1950 to 8,000 tons in 2000. Zinc-lead ore reserves accounts for 390 million tons. These are mostly limited to Rajasthan. The ores contain 8-16% of zinc and 2-18% of lead content. Zinc production is about 149 thousand tons and lead production is about 65 thousand tons in India (1999).

Metallurgical grade ores of rare metals like silver, cobalt, tin, titanium, cadmium, chromium, manganese and zirconium, etc. are available in India.

Conclusion

Inorganic compounds are a significant portion of mineral elements which cannot be consumed excessively. The main worry is – 'Are we able to afford the environmental cost of such a rapid and enormous mineral extraction?'. We are already facing numerous environmental problems associated with mining industry. It is most essential to protect the fragile environment from extreme mineral extraction crisis.

Uses and Exploitation

Reserves find consumption in a great number of methods in daily usage of local, farming, manufacturing and marketable divisions, and therefore create a significant share of any country's financial standing.

The foremost usages of reserves are given below:

1. Expansion of manufacturing floras and equipment.
2. Generation of energy, e.g., coal, lignite and uranium.
3. Building, housing and settlements.
4. Defense equipment – weapons and armaments.
5. Transport methods.
6. Communication – phone cables, wires and electric machines.
7. Medical organization – predominantly in Ayurvedic structure.
8. Creation of amalgams for numerous usages (e.g., phosphorite).
9. Farming as manures, seed coverings and antifungals (e.g., zinc containing zinc, Maneb-containing manganese, etc.)
10. Jewelry, e.g., gold, silver, platinum, diamond.

Grounded on their possessions, reserves are essentially of two kinds:

1. Non-metallic reserves, e.g., graphite, diamond, quartz, feldspar, etc.
2. Metal reserves, e.g., Bauxite, latent, hematite, etc.

Utilization of metallic elements by human beings is largely extensive since the start of human development that two of the main areas of human history are called after them as Bronze Age and Iron Age. The assets of metallic element and the practical knowledge to remove them have been the important fundamentals in defining the financial and radical power of countries. Numerous metallic elements exist globally but the prime metal which is utilised in supreme amount is iron and steel (740 million metric tons annually) trailed by manganese, copper, chromium, aluminium and nickel.

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Supply and utilisation of few foremost metal and non-metal reserves are stated in subsequent tables.

Table 2.3: Main Assets and Significant Usages of Few Foremost Metallic Elements

Metals	Major World Reserves	Major Uses
Aluminium	Australia, Guinea and Jamaica	Packaging diet substances, transport, tools and electrical devices
Chromium	CIS and South Africa	For making high strength steel, amalgams and in fabric/tanning businesses
Copper	USA, Canada, CIS, Chile and Zambia	Electric and electronic construction, vessels goods and building
Iron	CIS, South America, Canada and USA	Heavy machinery, steel production and transportation means
Lead	North America, USA and CIS	Leaded petrol, car batteries, tints and ammunition
Manganese	South Africa, CIS, Brazil and Gabon	For making high strength and heat-resistant steel alloys
Platinum Group	South Africa and CIS	Use in vehicles, catalytic convertors, electrical devices and medicinal usages
Gold	South Africa, CIS and Canada	Ornaments, medicinal usage, electric usage and usage in space
Silver	Canada, South Africa and Mexico	Photography, electronics and jewelry
Nickel	CIS, Canada and New Caledonia	Chemical, industry and steel alloys

Table 2.4: Main Usages of Few Non-metal Reserves

Non-metal Minerals	Major Uses
Silicate minerals	Sand and gravel for construction, bricks, paving, etc.
Limestone	Used for cement, construction pebble, usage in farming for counterbalancing acid soil, used in concrete manufacturing, etc.
Gypsum	Used in plaster, wall-board, in agriculture, etc.
Potash and phosphorite	Used as fertilizers
Sulphur pyrites	Used in medicine, car battery, industry, etc.

(a) **Jaduguda Uranium Mine, Jharkhand:** Revealing resident people to dangerous threats.

(b) **Jharia Coal Mines, Jharkhand:** Basement fire causing landscape subsiding and enforced movement of individuals.

(c) **Sukinda Chromite Mines, Odisha:** Leaking of hexavalent chromium into stream causing severe health related threat, Cr64 being extremely poisonous and cancer-causing.

(d) **Kudremukh Iron Ore Mine, Karnataka:** Triggering waterway contamination and danger to ecosystem.

(e) **East Coast Bauxite Mine, Odisha:** Property infringement and problem of restoration unresolved.

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(f) North-eastern Coal Fields, Assam: Extreme Sulphur pollution of groundwater.

Impacts of Mining: Withdrawal is completed to obtain reserves (or remnant fuels) from bottom-most reserves in soil by using sub-surface mining or from shallow deposits by surface mining. The previous technique is very damaging, hazardous and costly counting in dangers of work-related threats and mishaps.

Surface mining can make usage of any of the subsequent three kinds:

(a) Open-pit Mining in which machineries excavate holes and dig out the minerals (e.g., copper, iron, gravel, limestone, sandstone, marble, granite, etc.).

(b) Dredging in which chained buckets and draglines are used which scrap up the minerals from underwater mineral deposits.

(c) Strip Mining in which the mineral is exposed off by means of bulldozers, power shovels and uncovering wheels (e.g., phosphate rocks).

The ecological harm instigated by removal actions are as follows:

(i) Devegetation and Defacing of Landscape: The topmost soil as well as the flora are detached from the removal portion to get access to the reserve. While large-scale desertification causes numerous environmental damages as previously conversed in the earlier unit, the land also gets seriously damaged. The vast amounts of wreckages and followings along with large mutilations and disturbances damage the visual worth of the area and make it susceptible to soil corrosion.

(ii) Subsidence of Land: This is mostly related with underground removal, dropping of removal parts frequently, consequences in leaning of structures, cracks in houses, buckling of roads, etc.

It is obvious from the Tables that the CIS countries (The Commonwealth of Independent States, i.e., 12 republics of former USSR), the United States of America, Canada, South Africa and Australia are consuming the main global assets of maximum of the metal reserves. Because of enormous inorganic and radiation properties, the USA became the wealthiest and the maximum commanding country globally in less than 200 years. Japan too, needs a mention here, as there are virtually no metal reserves, coal, oil and timber resources in Japan, and it is totally dependent on other countries for its resources. Nonetheless, it has advanced radiation effective machineries for the advancement of these properties to maximum standard of quality completed goods to withstand its economy.

Reserves are occasionally categorised as **Critical** and **Strategic**.

Critical minerals are vital for the wealth of a country, e.g., iron, aluminium, copper, gold, etc.

Strategic minerals are those mandatory for the protection of a nation, e.g., manganese, cobalt, platinum, chromium, etc.

Some Major Minerals of India

(a) Energy Generating Minerals:

Coal and Lignite – West Bengal, Jharkhand, Orissa, Madhya Pradesh and Andhra Pradesh.

Uranium (Pitchblende or Uranite Ore): Jharkhand, Andhra Pradesh (Nellore, Nalgonda), Meghalaya and Rajasthan (Ajmer).

(b) Other Commercially Used Minerals:

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Aluminium (Bauxite Ore): Jharkhand, West Bengal, Maharashtra, Madhya Pradesh and Tamil Nadu.

Iron (hematite and Magnetite Ore): Jharkhand, Orissa, Madhya Pradesh, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Goa.

Copper (Copper Pyrites): Rajasthan (Khetri), Bihar, Jharkhand, Karnataka, Madhya Pradesh, West Bengal, Andhra Pradesh and Uttarakhand.

Environmental Effects of Extracting and Using Mineral Resources

The matter linked to the restrictions of the inorganic properties in our earth's crust or in the ocean is not really important. A lot more significant ecological problems occur due to the effects of removal and refinement of these reserves through removal, melting, etc.

Indian Scenario: Our country, India is the manufacturer of 84 reserves, the yearly worth of which is around ₹ 50,000 crore. Minimum six foremost excavations require a reference here which are identified for triggering serious complications.

Bending of rail tracks and leaking of gas from cracked pipelines leading to serious disasters.

(a) Groundwater Contamination: Removal interrupts the natural hydrological procedures and also contaminates the groundwater. Sulphur, naturally present as a contamination in many minerals, is recognized to get changed into sulphuric acid because of bacterial activities, thus turning it into acidic water. Few hefty metallic components also get leaked into the groundwater and pollute it causing health related threats.

(b) Surface Water Pollution: The acidic pit discharge frequently pollutes the neighboring rivers and ponds. The acid water is harmful to numerous life-forms of water. Occasionally dangerous materials like uranium also pollute the water bodies due to excavation, waste matters and killing marine faunas. Hefty metallic contamination of water bodies nearby the withdrawal zones is severely generating health related dangers.

(c) Air Pollution: In order to separate and purify the metal from other impurities in the ore, smelting is done which emits enormous quantities of air pollutants damaging the vegetation nearby and has serious environmental health impacts. The suspended particulate matter (SPM), SOx, soot, arsenic particles, cadmium, lead etc. Shoot up in the atmosphere near the smelters and the public suffers from several health problems.

(d) Occupational Health Hazards: Maximum of the mine workers experience numerous breathing and skin illnesses because of continuous contact to the deferred particulate matter and poisonous elements. Mine workers employed in various kinds of excavations are affected from asbestosis, silicosis, black lung disease, etc.

Remedial Measures: Security of mine workers is typically not an important topic of business. Numerical information display that, on an average, there are 3D non-fatal but incapacitating mishaps per ton of inorganic matter formed and one death per 2.5 tons of inorganic matter formed.

To minimise the opposing effects of removal, it is necessary to accept ecological withdrawal machinery. The inferior minerals can be utilised well by applying **microbial-leaching technique**. The bacterium *Thiobacillus ferrooxidans* has been effectively and carefully utilised for removing gold entrenched in iron sulphide mineral. The minerals are immunised with the required straining of microorganisms, which eliminate the scums

(like Sulphur) and only the clean ores are left behind. This organic technique is beneficial for financial and ecological concerns as well.

Renovation of excavated zones by afforestation and planting apt vegetal types, maintenance of the excavated properties, steady rebuilding of plants, stoppage of poisonous drainage release and meeting the required levels of air releases are vital for diminishing ecological effects of excavation.

Case Studies on Minings

(Excavations in India)

1. **Mining and Quarrying in Udaipur:** Approximately 200 exposed company excavations and mining midpoints in Udaipur, nearly half of them are unlawful and engage in stone mining counting in soapstone, building stone, rock, phosphate and dolomite. These excavations spread across 15,000 hectares in Udaipur have triggered numerous opposing effects on atmosphere. Approximately 150 tons of incendiary devices are implemented each month in explosions. The overload, wash off, release of excavation water, etc. contaminate the water. The Maton excavations have severely contaminated the Ahar river. The mountains near the excavations are barren of any flora excluding some dispersed areas and the mountains are facing severe soil corrosion. The contaminated water moves in the direction of a big tank of "Bag Dara". Because of shortage of water, individuals are obliged to make use of this waste water for agricultural practices. The explosive actions have harmfully impacted the animals like tiger, lion, deer, hare, fox, wild cats and birds have vanished from the excavation zones.
2. **Mining in Sariska Tiger Reserve in Aravallis:** The Aravalli Range is spread across approximately 62 kms in the North-West India covering Gujarat, Rajasthan, Haryana and Delhi. The mountain area is enriched in biodiversity as well as inorganic supplies. The Sariska Tiger Reserve has moderate sloppy mountains, upright stony valleys, smooth grasslands and steep valleys too. The reserve is enriched in wildlife, and has huge inorganic reserves like quartzite, schists, marble and granite in plenty.

   Excavation processes inside and near the Sariska Tiger Reserve has turned several zones forever unproductive and unfruitful. The valuable wildlife is below severe danger. We should essentially protect the Aravalli series as a National Heritage and the Supreme Court on December 31, 1991 has passed a decision in reply to a Public Interest Litigation of Tarun Bharat Sangh, an NGO in which both Centre and State Government of Rajasthan have been ordered to safeguard that all removal actions inside the park must be prohibited. Further, 400 excavations and plus more were closed directly after this. Still, few unlawful removals are still in process.
3. **Uranium Mining in Nalgonda, Andhra Pradesh – The Public Hearing:** The current assets of Uranium in Jaduguda Mines, Jharkhand can supply the yellow cake only till 2004. There is a persistent necessity for removing additional uranium to fulfil the requests of India's nuclear program. The Uranium Corporation of India (UCIL) proposes to mine uranium from the deposits in Lambapur and Peddagattu villages of Nalgonda district in Andhra Pradesh and a processing unit at about 18 kms at Mallapur. The strategy is to remove the minerals of 11.02 million tons in 20 years. The UCIL is making attempts to attract village individuals with job prospects. But authorities pay the business for keeping hush on the likely pollution of water bodies in the

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zone. The projected excavations are just 1 km from human inhabitation and barely 10 kms from Nagarjuna Sagar Dam and hardly 4 kms from the Akkampalli reservoir which is Hyderabad's new source of drinking water. It is projected that 20 years of removal would produce about 7.5 million metric tons of dangerous waste matter, of which 99.9% will be stay back. The villagers are very probable to be affected by the dangerous waste matter. Though MCL claims that there won't be any such accidents, but no one can deny that it is an extremely dangerous manufacturing and security actions cannot be ignored. The pitiful situation of Jaduguda Uranium Mines in Jharkhand where there is a black history of enormous deceases and destruction have annoyed the community, who don't want it to be repeated for Nalgonda.

The planned excavations would cover about 445 ha of Yellapurum Reserve Forest and the Rajiv Gandhi Tiger Sanctuary. The community hearing held just recently in February 2004 saw powerful objections from NGOs and many villagers. The destiny of the planned excavation is yet to be definite.

2.5 Food Resources

Nowadays, our nourishment derives nearly totally from farming, animal husbandry and fishing. Although India is independent in food manufacture, this is only because of contemporary outlines of farming that are unmaintainable and which contaminate our atmosphere with extreme utilisation of manures and insecticides.

The FAO (Food and Agricultural Organisation) outlines maintainable farming as that which saves land, water and plant and animal genetic resources, do not damage the atmosphere, and is financially feasible and socially suitable. Maximum of big farms produce solitary crops (monoculture). If this crop is attacked by insects, the entire crop can be distressed and the farmer will have no revenue through the year. On the other hand, if the farmer practices old-style variabilities and produces numerous dissimilar crops, the chance of total loss is dropped significantly. Numerous lessons have revealed that one can use replacements to mineral manures and insecticides. This is known as Integrated Crop Management.

World Food Problems: In many emerging nations where inhabitants are increasing quickly, the manufacture of food is incapable to keep pace with the increasing wants. Food manufacture in 64 of the 105 developing nations is lagging behind their inhabitant's development stages. These nations are incapable to harvest additional food, or do not have the financial means to import it. India is one of the nations that have been able to harvest sufficient food by cultivating a large proportion of its arable land through irrigation. The Green Revolution of the 60s decreased hunger of the nation. Though, numerous of the machineries we have implemented to attain this are now being questioned.

Our productive soils are being subjugated sooner than they can recover.

Woodlands, plains and wetlands have been transformed to farming use, which has caused several environmental inquiries.

Our fish resources, both marine and inland, display sign of collapse.

There are countless differences in the obtainability of nourishing food. Some communities such as tribal people still experience severe food difficulties causing malnutrition particularly amongst females and kids.

These matters increase fresh queries as to how the wants will be fulfilled in future, even with a reducing inhabitant's development. Nowadays, the ecosphere is observing a varying tendency in dietary habits. As living standards are increasing, humans are

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consuming additional non-vegetarian food. Humans have shifted from eating grain to meat, the world's demand for feed for cattle, grounded on farming, upsurges too. This uses more land per unit of food harvested and the consequence is, the underprivileged do not get sufficient food to consume.

Females perform a tremendously important part in diet manufacture as well as in cooking meals and feeding children. In maximum village groups, they have the smallest experience to practical training and to health workers trained in teaching/learning on issues related to nutritional aspects. Females and young girls often obtain a smaller amount of food than the men. These differences required to be revised.

In India, there is a lack of cultivatable fruitful property. Therefore, farm sizes are too small to sustain a household on farm harvest solely. With every new group of generation, farmlands are being divided more. Bad ecological farming practices such as slash-and-burn, shifting cultivation, or rab (wood ash) cultivation damage the woodlands.

Worldwide, 5 to 7 million ha of woodland is damaged annually. The damage of nutrients and the overdoing of farming chemical substances are the main issues in property deprivation. Marine shortage is a significant feature of bad farming productions. Salinisation and water logging has impacted a big quantity of farming property universally.

The damage of heritable variety in crop plants is an additional problem that is resulting in reduction in farming harvest. Rice, wheat and corn are the staple foods of two-thirds of the world's people. As wild relatives of crop plants in the world's grasslands, wetlands and other natural, habitats are being lost, the capability to improve qualities that are resilient to sicknesses, saltiness, etc. is also being lost. Inherited manufacturing is an untested and dangerous substitute to old-style cross-breeding.

Food Security: It is projected that 18 million people universally, maximum of whom are kids, decease annually because of hunger or undernourishment, and countless others face a variation of nutritional insufficiencies.

The Earth sources a partial quantity of food. If the world's carrying capacity to produce food fails to fulfil the increasing wants of rising inhabitants, chaos and battle will trail. Therefore, diet safety is carefully related with inhabitant's regulation by the family well-being plan. It is also related to the obtainability of water for agricultural purposes. Diet safety is solitarily probable if diet is justifiably circulated to everyone. Several human beings waste a great quantity of food. This ultimately puts excessive pressure on our ecological possessions.

Additional main fear is the sustenance required for small farmers so that they continue to stay farmers rather than changing to city centers as untrained manufacturing workforces. Global business rules with regards to a better distribution of food all over nationwide boundaries from those who have excess to those who have a shortfall in the emerging world is additional problem that is a fear for authorities who handle global business alarms. 'Dumping' of underpriced harvests formed in the industrialized nations into marketplaces of underdeveloped nations weakens harvest charges and leaves farmers with no choice but to accept unmaintainable actions to withstand competition.

Fisheries: Fish is a significant product of protein supply in several nations globally. This consists of both, sea and freshwater fish. While the source of diet from fisheries has amplified remarkably amid 1950 and 1990, in numerous regions of the world, fish catch has subsequently lessened because of overfishing. In 1995, FAO reported that 44% of the world's fisheries are completely or seriously damaged, 16% are by now damaged, 6% are exhausted, and only 3% are slowly improving. Canada had to almost shut down cod fishing in the 1990s because of serious reduction of its fish reserves.

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Modern fishing machines using automatic draggers and small interlocked nettings causes severe overuse, which is unmaintainable. It is clear that fish have to breed effectively and require to have time to grow if the yield has to be used sustainably. The small traditional fishermen, who are no match for organized trawlers, are severely impacted by these advances.

Damage of Hereditary Variety: There are 50,000 recognized eatable floras known universally. Out of these, only 15 diversities form 90% of the world's food. Modern farming actions have caused a severe damage of hereditary diversity of harvests. India's distinguishing old-style diversities of rice alone are said to have numbered between 30 and 50,000. Maximum of these have been lost to the farmer during the last few decades, as multinational seed companies aggressively push a few commercial genotypes. This generates a danger to our diet safety, as farmers can misplace entire harvest due to a fast spreading illness. On the other hand, a cereal that has numerous diversities rising in dissimilar sites do not allow the fast spread of an illness.

The greatest operative technique to present required qualities into crops is by means of features found in the wild relatives of crop plants. As the wilderness shrinks, these diversities are quickly vanishing. When they are totally gone, their needed features won't be presented when needed in the future. Safeguarding long-standing diet safety may be subjected to preserving the wild relatives of crop plants in nationwide grounds and nature preserves.

If plant genetic losses universally if not decelerated, few estimations display that 60,000 flora breeds, which accounts for 25% of the world's total, will be lost by the year 2025. The greatest inexpensive method to stop this is by increasing the efficient system and accurate handling of our Protected Areas. Collections in germplasm, seed banks and tissue culture facilities are additional probable methods to stop death, but these are tremendously costly.

Scientists now believe that the world will soon need a second green revolution to meet our future demands of food, based on a new ethic of land and water management that must incorporate values which include environmental sensitivity, equity, biodiversity, conservation of and *in-situ* preservation of wild relatives of crop plants. This must not only provide food for all, but also work out a more impartial supply of both, food and water, reduce agricultural dependence on the use of fertilizers and pesticides (which have long-term ill-effects on human well-being) and provide an increasing support for preserving wild relatives of crop plants in Protected Areas. The pollution of water sources, land degradation and desertification must be rapidly reversed. Adopting soil conservation measures, using appropriate farming techniques, especially on hill-slopes, enhancing the soil with organic matter, rotating crops and managing watersheds at the micro-level are the keys to agricultural production to meet the needs of our future generation. Most importantly, food supply is closely linked to the effectiveness of population control programs worldwide. The world needs better and more sustainable methods of food production, which is an important aspect of land use management.

Alternate Food Sources: Food can be creatively harvested if we stop the present farming styles. This consist of finding fresh paths to harvest food, such as usage of woodlands for their numerous non-wood forestry goods, which can be used for food if harvested sustainably. This includes fruits, mushrooms, sap, gum, etc. This will, of course, take time, as people must develop a taste for these new foods.

Medications, both old-style and modern, can be reaped sustainably from woodlands. Madagascar's Rosy Periwinkle used for childhood leukemias and Taxol obtained from Western Yew from the American North-West as an anti-cancer drug are

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examples of forest products used extensively in modern medicine. Without due care, commercial exploitation can lead to the early extinction of such plants.

Israel's Drip-Irrigated Farming Use of Water – Case Study

The small and arid state of Israel began using drip irrigation systems, as it is short of water. With this technique, Israeli farmers have been able to improve the efficiency of irrigation by 95%. Over a few years period, Israel's food production has doubled without an increase in the use of water for agriculture. Today, Israel is one of the major suppliers of fruits and vegetables in the world.

In India, some traditional communities in urban and semi-urban towns used to grow their own vegetables in backyards, using waste water from their own homes. Kolkata releases its waste-water into surrounding lagoons in which fish are reared and the water is also used for growing vegetables.

Using unfamiliar crops such as Nagli, which are grown on poor soil on hill slopes, is another option. This crop, found in the Western Ghats, has no market at present and is thus rarely grown. Only local people use this nutritious crop themselves. Therefore, it is not as extensively cultivated. Popularizing this crop could add to food availability from marginal lands. Several crops can be grown in urban settings, including vegetables and fruit, which can be grown on waste household water and fertilizers from vermicomposting pits.

Numerous foods can be promoted from yet unused seafood products, like seaweed, as long as this is done at maintainable levels. Educating women about nutrition, who are more closely involved with feeding the family, is an important aspect of supporting the food needs of many developing countries.

Integrated Pest Management includes preserving pest predators, using pest resistant seed varieties, and reducing the use of chemical fertilizers should also be adopted for sustainable food production.

Table 2.5: Impacts of Malnutrition

Deficiency	Health Effect	Number of Cases	Deaths per year (in millions)
Proteins and Calories	Stunted growth, Kwashiorkor, Marasmus	750 million	15-20
Iron	Anemia	350 million	0.75-1
Iodine	Goitre, Cretinism	150 million, 6 million	
Vitamin A	Blindness	6 million	

World Food Problems

During the last 50 years, world grain production has increased almost three times thereby increasing per capita production by about 50%. But, at the same time, population growth increased at such a rate in LDCs (less developed countries) that it has outstripped food production. Every year 40 million people (50% of which are young children between 1 to 5 years) die of undernourishment and malnutrition. ***This means that every year our food problem is killing as many people as were killed by the atomic bomb dropped on Hiroshima during World War II.*** These startling statistical figures emphasize the need to increase our food production, equitably distribute it and also to control population growth.

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Indian Scenario: Although India is the third largest producer of staple crops, an estimated 300 million Indians are still undernourished. India has only half as much land as USA, but it has nearly three times population to feed. Our food problems are directly related to population.

The World Food Summit, 1996 has set the target to reduce the number of undernourished to just half by 2015, which still means 410 million undernourished people on the earth.

Changes Caused by Agriculture and Overgrazing

A. Overgrazing

Cattle prosperity performs a vital role in the rural life of our country. India leads in cattle populace globally. The enormous inhabitants of cattle require to be fed and the graze lands or meadow parts are not satisfactory. Most frequently, we find that the cattle graze on a specific part of grassland or pasture exceed the carrying capacity. Carrying capacity of any system is the maximum population that can be supported by it on a supportable basis. However, most often, the grazing pressure is so high that its carrying capacity is crossed and the sustainability of the grazing lands fails. Let us see what are the impacts of overgrazing.

Impact of Overgrazing

(i) Land Degradation: Overgrazing eliminates the botanical shelter above the soil and the bare soil gets compressed because of which the functioning soil depth deteriorates. So, the roots cannot go much deep into the soil and satisfactory soil moistness is unobtainable. Biological reprocessing also deteriorates in the ecology due to massive debris or clutter leftovers on the soil to get decayed. The humus content of the soil declines and overgrazing leads to naturally bad, dehydrated and compressed soil. Because of trample by livestock, the soil drops penetration abilities, which further decreases purification of water into the soil and causes additional water to get vanished from the ecology along with exterior overflow. Thus, overgrazing results in numerous activities, subsequent damage of soil construction, hydraulic conduction and mud fruitfulness.

(ii) Soil Erosion: Due to overgrazing by livestock, the shelter of flora nearly gets detached from the land. The soil becomes bare and gets wind-swept by the action of powerful breeze, rainwater, etc. The grassroots are very good binders of soil. When the lawns are detached, the soil turns loose and vulnerable to the activities of wind and water.

(iii) Loss of Useful Species: Overgrazing unfavorably disturbs the structure of vegetal populace and their revival capacity. The original grassland comprises of good quality grasses and forbs with high nutritive value. When the livestock graze upon them heavily, even the root stocks which carry the reserve food for regeneration gets ruined. Now, some other species appear in their place. These secondary species are stronger and are less nutritive in nature. Some livestock keep on overgrazing on these species too. Ultimately, the nutritious, juicy fodder giving species like Cenchrus, Dichanthium, Panicum and Heteropogon, etc. are substituted by inedible and sometimes thorny plants like Parthenium, Lantana, Xanthium, etc. These species do not have a good capacity of binding the soil particles and, therefore the soil becomes more prone to erosion.

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As a result of overgrazing, vast areas in Arunachal Pradesh and Meghalaya are getting invaded by thorny bushes, weeds, etc. of low fodder value. Thus, overgrazing makes the land lose its redeveloping capacity and once a good quality pasture land gets converted into an ecosystem with poor quality thorny vegetation.

B. Agriculture

In the early years of human existence on this earth, man was just a hunter gatherer and was quite like other animal species. Some 10,000 to 12,000 years ago, he took to agriculture by cultivating plants of his own choice. He used the practice of **Slash and Burn cultivation or shifting cultivation**, which is still prevalent in many tribal areas, as in the North-East Hills of India. The type of agriculture practiced these days is very different from the traditional ones and their outputs in terms of yield as well as their impacts on the environment show lots of differences.

Traditional Agriculture and its Impacts: It usually involves a small plot, simple tools, naturally available water, organic fertilizer and a mix of crops. It is more near to natural conditions and usually it results in low production. It is still practiced by about half the global population.

The main impacts of this type of agriculture are as follows:

(i) Deforestation: The slash and burn of trees in forests to clear the land for cultivation and frequent shifting result in loss of forest cover.

(ii) Soil Erosion: Clearing of forest cover exposes the soil to wind, rain and storms, thereby resulting in loss of top fertile layer of soil.

(iii) Depletion of Nutrients: During slash and burn, the organic matter in the soil gets destroyed and most of the nutrients are taken up by the crops within a short period, thus making the soil poor in nutrients, which makes the cultivators shift to another area.

Modern Agriculture and its Impacts: It uses hybrid seeds of selected and single crop variety, high-tech equipment and lots of energy subsidies in the form of fertilizers, pesticides and irrigation water. The food production has increased tremendously, demonstrated by “green revolution”. However, it also gave rise to several problematic off-shoots as discussed below:

1. **Impacts Related to High Yielding Varieties (HYV):** The uses of HYVs encourage monoculture, i.e., the same genotype is grown over vast areas. In case of an attack by some pathogen, there is entire destruction of the crop by the ailment because of precisely unvarying circumstances, which aid in fast circulation of the illness.
2. **Fertiliser-Related Problems:**
   - **(a) Micronutrient Imbalance:** Maximum of the biochemical manures utilized in contemporary farming have nitrogen, phosphorus and potassium (N, P and K) that are vital macronutrients. Farmers typically make use of these manures extensively to increase up crop development. Extreme utilization of manures reason in *micronutrient imbalance.* For instance, extreme manure utilization in Punjab and Haryana has triggered shortage of the micronutrient zinc in the soils, which is disturbing the efficiency of soil.
   - **(b) Nitrate Pollution:** Nitrogen-bearing manures used in the fields frequently percolate deep into the soil and eventually pollute the groundwater. The nitrates get concentrated in the water and when their concentration

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exceeds 25 mg/L, they become the reason of a severe health-related danger termed **"Blue Baby Syndrome"** or Methemoglobinemia. This sickness impacts the babies to an all-out degree triggering demise. In Denmark, England, France, Germany and Netherlands, this problematic situation is fairly predominant. In India also, problem of nitrate contamination occurs in several zones.

(c) Eutrophication: Extreme utilization of N and P manures in the farming arenas causes additional problematic situation, which is not linked to the soil, but is related to water bodies like lakes. A big amount of nitrogen and phosphorus used in crop fields is washed off and along with excess water spread at the water bodies triggering overnourishment of the lakes, a procedure recognized as **Eutrophication** (eu = more, trophic = nutrition). Due to eutrophication, the lakes get attacked by algae blooms. These algae breeds produce rapidly consuming all the nutrients. They are habitually poisonous and seriously impact the food chain. The algae breed rapidly finish their lifespan and decease thus accumulating more of deceased biological substance. The fishes are also slayed and there is too much of deceased substance that begins to get decayed. Oxygen is utilized in the procedure of disintegration, and shortly, the water gets exhausted of solvated oxygen. This additionally impacts marine animals and eventually anaerobiotic circumstances are formed where only infective anaerobiotic microorganisms can endure. Thus, due to extreme utilization of manures in the farming arenas, the lake bionetwork gets damaged. This displays how a careless act can have extensive effects.

3. **Pesticide-Related Problems:** Thousands of kinds of insecticides are utilized in farming. The first-generation insecticides consist of elements such as sulphur, arsenic, lead or mercury to kill the pests. DDT (Dichlorobiphenyl trichloroethane) whose insecticidal possessions were revealed by Paul Mueller in 1939 fits in the second-generation pesticides. After 1940, a big amount of artificial insecticides came into utilization. Though, these insecticides have gone a long way in shielding our harvests from massive damages happening because of insects, yet they have a number of side-effects as discussed below:

   (a) Creating Resistance in Pests and Producing New Pests: Roughly, a few breeds of the insects typically endure even after insecticide spray. The fighters upsurge to extremely resilient generations. About 20 breeds of insects are today recognized which have developed resistant to all kinds of insecticides and are identified as **"Super pests"**.

   (b) Death of Non-Target Organisms: Numerous pesticides are wide-ranging toxins which not only kill the targeted breeds but also numerous non-targeted breeds that are beneficial.

   (c) Biological Magnification: Numerous insecticides are non-biodegradable and keep on gathering in the food chain, a procedure called organic intensification. Since human beings inhabit a high trophic level in the food chain, they get the insecticides in a bio-magnified form which is extremely dangerous.

4. **Water Logging:** Overirrigation of croplands by farmers for good growth of their crop usually leads to water logging. Insufficient discharge facilities cause extra water to gather underground and slowly creates a non-stop pillar with the water table. Under water-logged circumstances, pore spaces in the soil get completely soaked with water and the soil-air gets exhausted. The water table

rises while the roots of plants do not get satisfactory air for breathing, motorized strength of the soil deteriorates, the crop plants get lodged and crop yield reduces.

In Punjab and Haryana, widespread zones have become water-logged where satisfactory canal water supply or tubewell water motivated the farmers to use it overenthusiastically resulting in water logging problematic situations. Averting extreme irrigation, sub-surface discharge machines and bio-drainage with trees like Eucalyptus are some of the corrective actions to avert water logging.

5. **Salinity Problem:** At current, 1/3rd of the entire cultivatable land zone of the globe is impacted by salinities. In India, about 7 million hectares of land are projected to be salinized which may be salty or sodic. Salty muds are characterized by the gathering of solvable salinities like sodium chloride, sodium sulphate, calcium chloride, magnesium chloride, etc. in the soil profile. Their electric conduction is more than 4 ds/m. Sodic soils have carbonates and bicarbonates of sodium. The pH usually exceeds 8.0 and the exchangeable sodium percentage (ESP) is more than 15%.

Salinity and Water Logging in Punjab, Haryana and Rajasthan

The primary disturbing account of salinized harsh environments creation in links with irrigation acts came from Haryana (then Punjab) in 1858. It was stated that numerous townships in Panipat, Rohtak and Delhi lying in command area of Western Yamuna Canal were suffering from damaging salty efflorescence. The “Reh Committee” in 1886 drew the consideration of the management on some significant opinions screening a close association between irrigation, drainage and spread of “reh” and “usar” soils.

Serious water logging with severe drain channels issues

Introduction of canal irrigation in 1.2 m ha in Haryana caused in growth inside water table trailed by water logging and saltiness in many irrigated zones triggering massive financial loss as a consequence of drop in harvest efficiency. Rajasthan too has suffered of a large part. Subsequently, the major irrigation project “Indira Gandhi Canal Project” and the sufferings of a big area in Western Rajasthan have altered from a situation of “water-starved wasteland” to that of a “water-soaked wasteland”.

Causes: A main reason of salinization of soil is extreme irrigation. About 20% of the world’s croplands receive irrigation with canal water or ground water which unlike rainwater often contains dissolved salts. Under dry climates, the water evaporates leaving behind salts in the upper soil profile.

Thousands of hectares of land area in Haryana and Punjab are affected by soil salinity and alkalinity. Saltiness reasons in underdeveloped vegetal evolution and drops harvest produce. Maximum of the harvests fail to stand extreme saltiness.

Fertilizer-Pesticide Problems

How Pesticides Endanger Our Life?

Pesticides acutely affect man, animal, plants, soil as well as the aquatic biota. Toxicity towards the aquatic flora and fauna is an important criterion for a pesticide to be considered as a hazardous pollutant. Pesticides affect in a variety of ways as follows:

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1. Effects on Man

- Higher concentration of DDT in body parts and blood of human beings causes anxiety, tension, cancer, mutations, stress reactions, congenital and impotency.
- Central nervous system is the target of DDT poisoning in man which ultimately leads to death. It dissolves in lipids and accumulates in the body fats (3 to 90 ppm).
- The most threatening facts is DDT concentrates and gathers in the food chain. It is uninterruptedly reprocessed in living organisms. The level of DDT estimated in human tissues lies in range of 5 to 10 ppm. According to an estimation, DDT concentration in man's body fat varies from 3.3 g/m^3 in UK to 25 g/m^3 in India.
- Low levels of DDT cause cancer, high blood pressure and cirrhosis of the liver. DDT also interferes with signal transmission at the synoptic gap.
- Insecticides like BHC, aldrin, dieldrin, chlordane and endosulfan are extremely toxic to living beings. These are considered to affect the vital organs, heart, brain, kidneys and liver producing long-lasting disorders.
- Pesticide 2,4,5-T consists of highly toxic component called dioxin or TCDD which is teratogen and liable to cause congenital malformations.
- Organophosphates like ethion, fenthion, dimethoate, trithion, monocrotophos, diazinon, dursban, phosdrin, thionazin and metasystox inhibit the production of cholinesterase at the junction between adjoining nerve cells with the result that cholinesterase breaks down acetylcholine secreted by nerve cell axons. Excessive accumulation of acetylcholine interferes with the nerve impulse transmission. The organophosphorus insecticides such as parathion, malathion and TEPP may be absorbed by the lungs, eye membrane and skin to toxic amounts. This excessive absorption leads to larger gathering of acetylcholine in the body disturbing the normal functioning of blood.
- Long-lasting gathering of insecticides performs a key role in liver and kidney malfunctioning, secretion of surplus of amino acids in human blood and urine, blood abnormalities as well as electroencephalogram deformations of brain tissue.
- The hazard of longstanding ingesting of insecticide scum in diet is extremely severe from intoxication point of view of nationwide well-being.
- Nowadays, kids born have to begin their life with a body burden of insecticides that upsurges with age. Pesticides are also reported to cause continuing impotency in men.
- The 2,4,5-trichloro phenoxy acetic acid is teratogenic and feticidal in lower mammals.
- Pesticide poisoning in Kerala (1951) resulted in death of 112 people while in Indore (1968), 35 cases of malathion poisoning were reported. On December 3, 1984, Bhopal industrial disaster was the worst-ever pesticidal MIC accident in history, taking an extraordinary and still unaccounted death toll leaving no fewer than 50,000 quickly dwarfed by the tidal wave of man's suffering that spread across the central city like the poison cloud. This carbaryl (carbamate pesticide) leakage caused an increased risk of sleeping, digestive problems, vision problems and sterility.

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2. Effects on Animals

- Insecticides such as aldrin, dieldrin, chlordane, endosulfan, heptachlor and gammaxene are reported to affect the wildlife by changing their metabolic activities and body chemistry.
- Animals which have become weak and moribund as a result of exposure to pesticides may easily be destroyed by predators.
- Chlorophenoxy acid compounds such as 2,4-0 affect embryos while triazones may cause mutagenic effects in animals.
- Organophosphate pesticides cause extreme muscular weakness, tremors and dizziness in poisoned animal.

3. Effects on Birds

- Pesticides such as parathion, malathion, aldrin, dieldrin, heptachlor and several other organochlorines are reported to affect severely the metabolism in birds. Many species of hunting birds, particularly those having high levels of DDT, are threatened with extinction.
- DDT has been concerned as the **main villain** and the cause of thin and fragile egg shells because of inhibition of enzymes and interference with the hormones that control calcium metabolism.
- Pesticide pollution reduces egg laying in birds and fewer young ones are hatched.

4. Effects on Aquatic Biota

Pesticides affect aquatic organisms as follows:

- Aquatic animals are extraordinarily sensitive even to low concentrations of DDT. Even one part of DDT per trillion seems to cause death in brine shrimps.
- Critical danger arises from DDT which results in changing the behavior and metabolic activities in sea animals.
- It is reported that marine invertebrates can concentrate pesticides by a concentration factor up to 70,000 or more.
- Experiments have shown that DDT causes depression of photosynthesis in planktons. It is very low concentration as 1 ppb has immobilizing effects on *Cynocephalus* species.
- Endrin is extremely toxic to fishes like blue gills and rainbow trout with LC 50 values being 9006 and 0007 ppm respectively, while DDT is much less toxic to these fishes with LC50 values being 0016 to 0018 ppm respectively.
- Even the raptorial hawks and falcons are severely affected by DDT which causes their breeding failures and deaths.
- New lessons have demonstrated that tremendously less amounts of insecticides which arrive in the marine environment can impact efficiency of creatures, kill eggs and larvae of clams and oysters, affect the behavior of fishes such as schooling and feeding, and worsen the water quality.
- Insecticides make variations in blood chemistry and enzymatic functions of marine invertebrates. They reduce their backbone collagen content and indirectly interfere with food chain.
- Since slight concentrations of organochlorine pesticides affect reproduction in fishes, there is every possibility that these pesticidal toxins might harmfully distress local fishery.

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- Varieties of Crustacea that make up the most valuable marine harvest are of course representatives of some groups of animals that pesticides are designed to kill, particularly sedentary animals which are unable to move away from pollutants. The Oysters might be susceptible because of their tendency to concentrate and store trace chemicals from the surrounding environment.
- Pesticides-induced mortality pattern of marine molluscs, crustaceans and teleosts are also measurably related to various physio-chemical environmental parameters like concentration of pesticide and duration of its exposure.
- PCBs are reported to be concentrated in the food chain of marine ecosystems.
- In a recent survey conducted by **US Public Health Service**, it was observed that insecticides were the reason of 32% fish kill in 1960, 21% in 1961, 18% in 1962, 30% in 1970 and these pesticidal pollutants ranked second to entire manufacturing waste matters.

5. Effects on Grains

- Many vegetables, fruits, rice, cereals and grains such as wheat, maze, grams and barley have been found to be contaminated with significant amounts of DDT and BHC. The level of DDT residue varies from 1.6 to 174 ppm in wheat, 0.8 to 164 ppm in rice, 3 to 17 ppm in pulses, 3 to 19 in ground nuts, up to 5 ppm in vegetables and 68.5 ppm in potatoes.

6. Effects of Pesticides on Soil

Pesticides not only pose possible dangers to man, animal, livestock, wildlife and fish, but they extremely affect the desired use of soil and water as follows:

- The most dangerous characteristic of pesticides, particularly organochlorines, is their long persistence in the soil which causes numerous adverse effects on grain quality.
- Even the accepted dosages of pesticides create deleterious effects in the long run in the soil.
- Insecticide reserved in the soil also concentrate in some crops, vegetables, cereals and fruits which defect them to an amount that they are not consumable.
- American Scientists observed that radishes and carrots grown on a loamy soil treated with aldrin at one 1b/acre contained 003 and 005 ppm of it respectively.
- Retention of pesticides in bottom soil of ponds renders them inappropriate for fish culture.
- Soil contaminated by pesticides also causes contamination of water resources, water supply and ground or surface water by ram.

7. Pesticides Contaminate Air Too

- Pesticidal introduction into air may occur through spraying operations, volatilizations, evaporation of chemicals from soil, plants or burning of plant products.
- Large quantities of DDT in human fat are attributed to the practice of spraying it inside the home in India.
- In a nutshell, if we continue to rely upon broad spectrum of pesticides, the recovery of natural forms of control will become almost impossible.

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Water Logging and Salinity

According to **National Commission of Agriculture**, water logging has impacted 7 m ha of agricultural land in canal irrigated areas. The Chambal project areas in Madhya Pradesh and Rajasthan, Kosi and Gandak projects in Bihar, and Tungabhadra areas in Karnataka and Nagarjuna Sagar in Andhra Pradesh are the major irrigation projects where **water logging** and consequent salinization have severely affected. Water logging and increased salinity are due to poor drainage in areas with massive irrigation projects.

Case Studies of Some Pesticide Accidents

The contrary effects of pesticides on the environment have been undesirable and disturbing. A huge sum of individuals have died by eating food which got contaminated accidently because of pesticides. Few cases are mentioned below:

1. 330 deaths occurred in Turkey due to eating seed grains treated with hexachlorobenzene.
2. 80 deaths occurred in Colombia from eating flour contaminated with parathion.
3. 17 deaths in Mexico were caused from eating sugar containing parathion.
4. In India, no accurate statistics are accessible on the morbidity and mortality from these toxicants. However, the records of Health and Agricultural Departments of Bihar, Mysore, Tamil Nadu, Maharashtra, West Bengal and Delhi throughout the previous few years showed that pesticides have been responsible for 185, 139, 1503, 690, 889 and 1210 of poisoning respectively. The toxins detected in over 80% of the cases are DOT, BHC, parathion, malathion, diazinon and endrin. The death toll is due to carelessness and ignorance.
5. A dangerous disease termed HANDIGODU was observed in rural areas of **Chikmangalur** and **Shimoga** in Karnataka. It was caused by faulty pesticide application in paddy and coffee fields. The persons who took fish frogs and crabs from the polluted rivers were found to be sufferers of diseases such as pain in the hip and knee-joints, abnormal growth of bones and abnormal changes in femoral head.
6. **TGDD Disaster at Seveso, Italy –** In **July 1976**, a white cloud of poisonous gas consisting of 2,3,7,8-tetrachlorobenzo-10-dioxin (TCDD) exploded in an herbicide (2,4,5-trichlorophenoxy acetate) manufacturing chemical plant. It engulfed the nearby town of Seveso and contaminated over buildings, grounds and soil. About 800 people were evacuated from the worst affected places by the Italian government Dioxin (Dibenzo-p-dioxin) TCDO (2,3,7,8-tetrachloro benzo-10-dioxin). Nearly 200 people suffered from respiratory, eye, gastrointestinal and liver diseases. The worst victims were pregnant ladies who gave birth to deformed and premature babies. According to researchers, dioxin will continue to contaminate soil, air and water which will frequently contaminate water resources and natural biological processes.
7. **Kepone Case –** in **1970** in **Hopewell**, **Virginia**, **USA**, a severe disaster occurred during the, production of Kepone – a chlorinated organic pesticide quite similar to DOT. Kepone is used for the control of tobacco from ants and cockroaches. The vegetal was linked to the Hopewell drainage structure. About 50,000 kgs of Kepone was discarded into the drainage structure for a year which was cleared into the Chesapeake Bay. Fish in the river showed 1 ppm of Kepone. It showed acute toxicity to birds, rodents and man. Employees of firm making Kepone inhaled its 3 g/m^3, but they did not know about the risk of cancer. They only knew about the tremors or shocks. These

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victims could not hold even a cup of coffee. Half of them have been hospitalized with complaints ranging from severe tremors, abnormal eye movements, slurring of speech, disorientation, chest and joint pain to liver and testicular damage. Finally, the plant was closed sixteen months after it had started operations.

According to **National Cancer Institute Test**, **81%** of the animals fed on low doses of this pesticide developed hepatocellular carcinomas.

Central Facility for Safety Evaluation of Pesticides

Recently, **Industrial Toxicology Research Centre (ITRC)**, **Lucknow** has established a Central Facility for Safety Evaluation of Pesticides with the following objectives:

- To generate toxicological data on different pesticides synthesized, manufactured or formulated by national laboratories and private sector industries within the country.
- To conduct carcinogenic, teratogenic and multigeneration studies on selected strains of experimental animals, *in vivo* tests using bacterial mutants, human cell lines and lymphocytes to map mutagenic and carcinogenic effects, and interference with immune mechanism.
- To study cytogenic effects of pesticides using bone marrow cells of intact animals.
- To develop new techniques for monitoring and predicting harmful effects of pesticides on target and non-target organisms and their diffusion in the environment.
- To provide expertise for diagnosing toxic hazard's symptoms and developing approaches of their stoppage and regulation.

Methods to Minimise Pesticidal Pollution

Fortunately, it is possible to treat persistent pesticides which contaminate in water bodies by the following techniques:

- Less persistent and harmless pesticides can be used instead of highly persistent ones.
- Proper utilisation of persistent pesticides would minimise drifts, etc.
- Pest control may be achieved biologically by the release of sterile males and entocones.
- Chemical methods like coagulation, volatilisation, irradiation, sedimentation and filtration can be adopted which can remove up to 90% DDT.
- Industrial wastes and effluents containing pesticides can be treated before they are released into water systems.
- Neem-based insecticide holds promise as an eco-friendly substitute.

2.6 Energy Resources

Energy consumption of a country is typically measured as a directory of its expansion. This is because nearly all the developing events are directly or indirectly reliant on energy. We discover extensive differences in per capita energy use between the developed and the developing nations.

The first form of energy technology probably was the fire, which produced heat and the early man used it for cooking and heating purposes. Wind and hydropower have

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also been in use for the last 10,000 years. The discovery of steam engines substituted the burning of wood by coal and coal was then substituted to an excessive amount by oil. In 1970s due to Iranian revolution and Arab oil embargo, the prices of oil increased. This eventually resulted in examination and usage of numerous alternative resources of energy.

Growing Energy Needs

Growth in diverse segments extensively depends upon energy. Farming, manufacturing, excavation, transport, lighting, cooling and heating in buildings all need energy. With the demands of rising inhabitants, we are experiencing additional energy shortfall. The remnant fuels like coal, oil and natural gas currently are providing 95% of the profitable energy of the world resources and will fail to withstand for the coming years. Our lifestyle is altering rapidly, and from a modest lifestyle, we are moving to an expensive lifestyle. If you just look at the number of electric gadgets in your homes and the number of private cars and scooters in your neighborhood, you will understand that their consumption has increased in the last few years.

Developed countries like USA and Canada constitute about 5% of the world's population, but consume one-fourth of global energy resources. An average person there consumes 300 GJ (Giga Joules, equal to 60 barrels of oils) per year. By contrast, an average man in a poor country like Bhutan, Nepal or Ethiopia consumes less than 1 GJ in a year. So, a person in a rich country consumes almost as much energy in a single day as one person does in a whole year in a poor country. This clearly shows that our lifestyle and standard of living are closely related to energy needs.

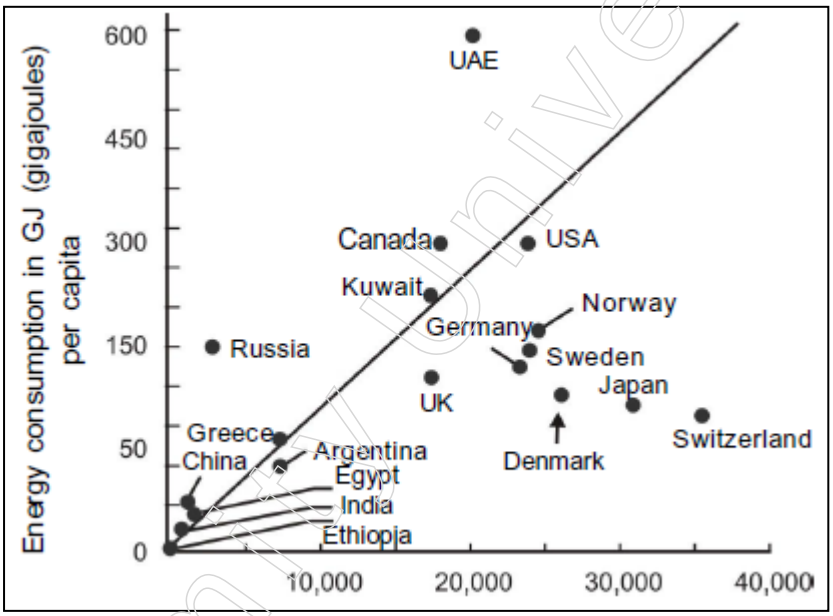

Fig. 2.1: Gross National Product (GNP): $ Per Capita

Fig. 2.1 shows the strong correlation between per capita energy use and GNP (Gross National Product). USA, Norway, Switzerland, etc. with high GNP show high energy use, while India, China, etc. have low GNP and low energy use. Bahrain and Qatar are oil rich states (UAE) and hence their energy consumption and GNP are more, although their development is not that high.

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Renewable and Non-Renewable Energy Sources

A foundation of energy is one that can offer satisfactory quantity of energy in a serviceable form over an extensive time period. These sources can be of two types:

1. **Renewable Resources which can be generated continuously in nature and are inexhaustible**, e.g., wood, solar energy, wind energy, tidal energy, hydropower, biomass energy, biofuels, geo-thermal energy and hydrogen. They are also known as non-conventional sources of energy and they can be utilized time and again in a boundless way.
2. **Non-Renewable Resources which have accumulated in nature over a long span of time and cannot be quickly replenished when exhausted**, e.g., coal, petroleum, natural gas arid nuclear fuels like uranium and thorium.

Wood is a renewable resource as we can get new wood by growing a sapling into a tree within 15-20 years, but it has taken millions of years for the formation of coal from trees and cannot be redeveloped in our lifetime. Hence, coal is non-renewable. We will now discuss numerous kinds of renewable and non-renewable energy resource.

1. Renewable Energy Resources

Solar Energy: Sun is the final basis of energy, directly or indirectly for all other forms of energy. The nuclear fusion reactions happening inside the sun emit massive amounts of energy in the form of heat and light. The solar energy received by the near-earth space is approximately 1.4 kilojoules/second/m^2 known as solar constant.

Conventionally, we have been consuming solar energy for drying clothes and foodgrains, conservation of edibles and for procurement of salt from seawater. Today, we have numerous methods for connecting solar energy. Few significant solar energy reaping appliances are conversed here.

(i) Solar Heat Collectors: These can be inactive or dynamic in nature. Inactive solar heat collectors are natural materials like stones, bricks, etc. or material like glass which soak sunrays in the day time and emit it gradually at night. Dynamic solar collectors pump a heat-soaking medium (air or water) through a small collector which is usually located on the topmost of the structure.

(ii) Solar Cells: They are also known as photovoltaic cells or PV cells. Solar cells are made of thin wafers of semi-conductor materials like silicon and gallium. When solar radiations fall on them, a potential difference is produced which causes flow of electrons and produces electricity. Silicon can be gained from silica or sand, which is plentifully obtainable and is cheap. By using gallium arsenide, cadmium sulphide or boron, efficiency of the PV cells can be improved. The potential difference produced by a single PV cell of 4 cm^2 size is about 0.4-0.5 volts and produces a current of 60 milliamperes.

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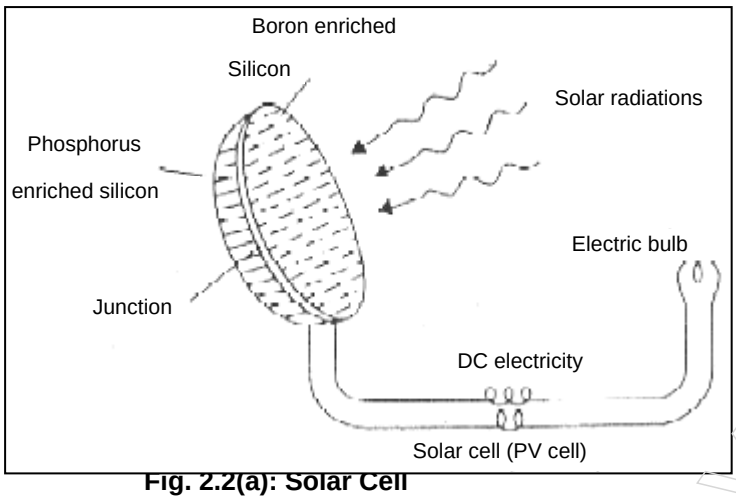

Fig. 2.2(a): Solar Cell

Fig. 2.2(a) shows the structure of a solar cell. A group of solar cells joined together in a definite pattern form a solar panel which can harness a large amount of solar energy and can produce electricity enough to run streetlight, irrigation water pump, etc. [Fig. 2.2(b)].

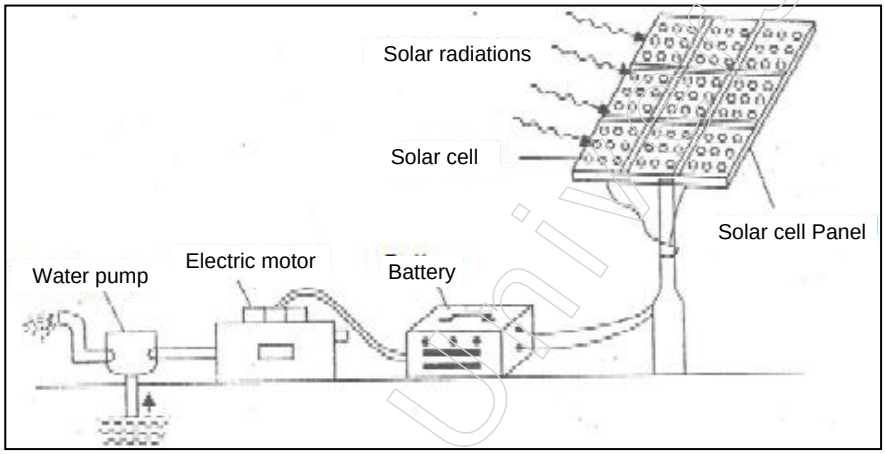

Fig. 2.2(b): A Solar Pump Run by Electricity Produced by Solar Cells

Solar cells are extensively utilized in calculators, electric timepieces, road lights, road traffic signs, water pumps, etc. They are also utilized in fake satellites for electrical energy production. Solar cells are used for running radio and television also. They are additionally used in distant zones where conventional electrical energy circulation is a problematic concern.

(iii) Solar Cooker: Solar cookers utilize solar heat by reflecting the solar radiations using a mirror directly on to a glass sheet which covers the black insulated box within which the raw food is kept as shown. A new design of solar cooker is now available which involves a spherical reflector (concave or parabolic reflector) instead of plane mirror that has more heating effect and hence greater efficiency.

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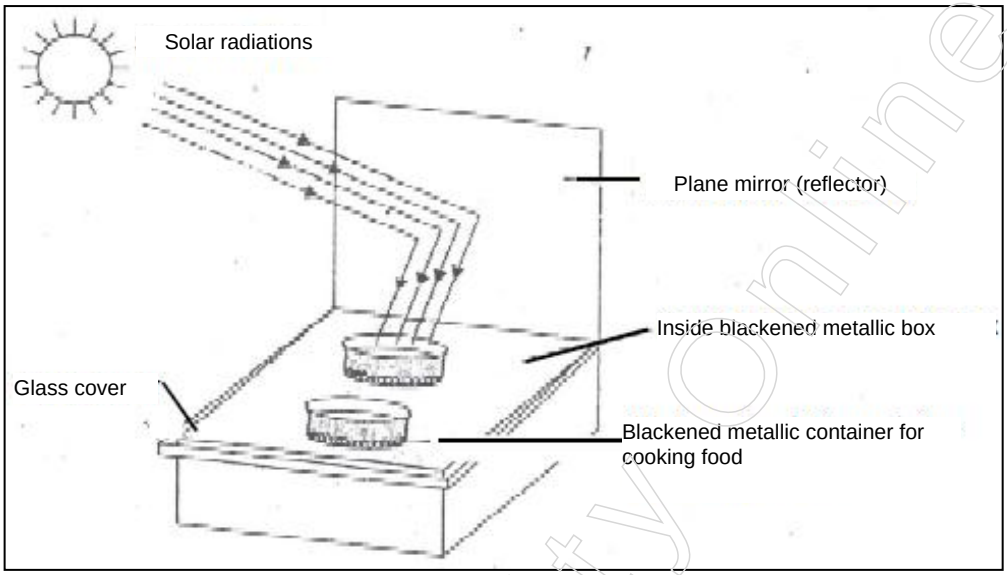

Fig. 2.3: Simple Box-type Solar Cooker

The food cooked in solar cookers is very nourishing because of slow heating. Though, it has restrictions that fails to make use of this device at night time or on rainy days. Furthermore, the direction of the cooker has to be adjusted according to the direction of the sunrays.

(iv) Solar Water Heater: It contains of an insulated box painted black from inside and having a glass lid to receive and store solar heat. Inside the box, it has black-painted copper coil through which cold water is made to flow in, which gets heated and moves out into a storage tank. The hot water from the storage tank fitted on rooftop is then supplied through pipes into buildings like hotels and hospitals.

(v) Solar Furnace: Here, thousands of small plane mirrors are arranged in concave reflectors, all of which collect the solar heat and produce as high a temperature as 3000^{o}C.

(vi) Solar Power Plant: Solar energy is connected extensively making use of concave reflectors which cause boiling of water to produce steam. The steam turbine drives a generator to produce electricity. A solar power plant (50-Watt capacity) has been installed at Gurgaon, Haryana.

Wind Energy

The high-speed winds have a lot of energy in them as kinetic energy due to their motion. The driving force of the winds is the sun. The wind energy is connected by implementing wind mills. The blades of the wind mill keep on spinning uninterruptedly because of the force of the prominent breeze. The rotating movements of the blades drives a number of machines like water pumps, flour mills and electric generators. A big sum of wind mills is fixed in groups called wind farms, which feed power to the utility grid and create a massive quantity of electrical energy. These farms are preferably situated in seaside areas, open plains or mountainous areas, predominantly foothill passes and ridges where the winds are strong and steady. The least wind speed mandatory for suitable operating of a wind generator is **15 km/hr**.

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The wind power potential of our country is estimated to be about 20,000 MW, while at present, we are generating about 1020 MW. The largest wind farm of our country is near Kanyakumari in Tamil Nadu generating 380 MW electricity. Wind energy is inexpensive. It is believed that by the middle of the century, wind power would supply more than 10% of world's electricity.

Hydropower

The water flowing in a river is collected by constructing a big dam where the water is stored and allowed to fall from a height. The blades of the turbine located at the bottom of the dam move with the speeding water which in turn rotate the generator and produces electricity. We can also construct mini or micro hydel power plants on the rivers in hilly regions for harnessing the hydro energy on a small scale, but the minimum height of the waterfalls should be 10 metres. **The hydropower potential of India is estimated to be about 4×10^{11} KW-hours**. Till now, we have utilized only a little more than 11% of this potential.

Hydropower do not cause in any contamination. It can be regenerated and usually the hydropower projects are multi-purpose projects aiding in regulating inundations, used for irrigation, navigation, etc. However, big dams are frequently linked with a numerous ecological effect which have been conversed in the earlier segment.

Tidal Energy

Ocean tides produced by gravitational forces of sun and moon contain enormous amounts of energy. The **'high tide'** and **'low tide'** refer to the rise and fall of water in the oceans. A variance of quite a few metres is mandatory between the height of high and low tide to spin the turbines. The tidal energy can be connected by building a tidal embankment. During high tide, the seawater flows into the reservoir of the embankment and moves the turbine, which in turn generates electrical energy by spinning the producers of energy. During low tide, when the sea level is low, the sea water stored in the embankment tank moves out into the sea and again spins the turbines (Fig. 2.4).

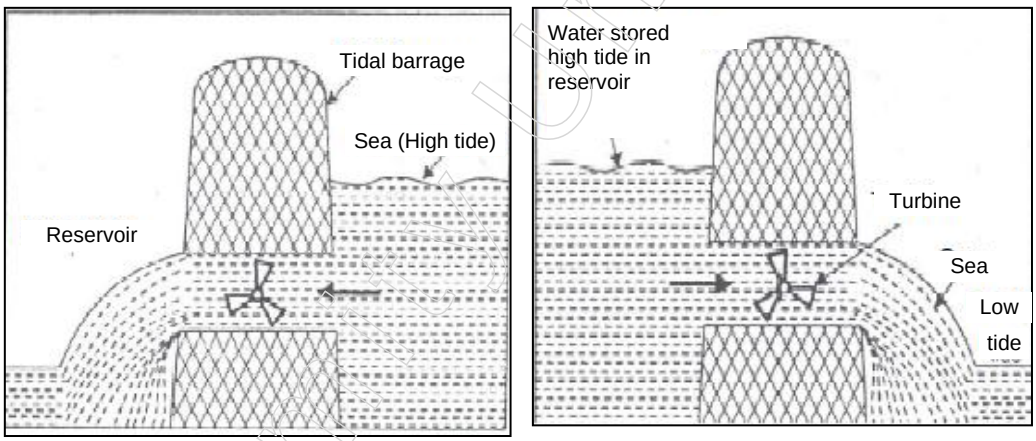

Fig. 2.4: (a) Water flows into the reservoir to turn the turbine at high tide, and (b) flows out from the reservoir to the sea, again turning the turbine at low tide

There are only a few sites in the world where tidal energy can be appropriately connected. The Bay of Fundy Canada having 17-18 m high tides has a potential of 5,000 MW of power generation. The tidal mill at La Rance, France is one of the first

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modern tidal power mill. In India Gulf of Cambay, Gulf of Kutch and the Sundarbans deltas are the tidal power sites.

Ocean Thermal Energy (OTE)

The energy obtainable because of the variance in temperature of water at the surface of the tropical oceans and at deeper levels is called Ocean Thermal Energy. A variance of 200C or extra is mandatory amongst exterior water and deeper water of ocean for operating OTEC (Ocean Thermal Energy Conversion) power plants. The warm surface water of ocean is used to boil a liquid like ammonia. The high compression fumes of the fluid created by boiling are then used to spin the turbine of a generator and create electrical energy. The colder water from the deeper oceans is pumped to cool and condense the vapors into liquid. Therefore, this procedure is non-stop and goes on for an entire day.

Geothermal Energy

The energy harnessed from the hot rocks present inside the earth is called geothermal energy. High temperature, high pressure steam fields exist below the earth's surface in many places. This heat comes from the fission of radioactive material naturally present in the rocks. In some places, the steam or the hot water comes out of the ground naturally through cracks in the form of **natural geysers** as in Manikaran, Kullu and Sohana, Haryana. Sometimes, the steam or boiling water underneath the earth do not find any place to come out. We can artificially drill a hole up to the hot rocks and by putting a pipe in it make the steam or hot water gush out through the pipe at high pressure which turns the turbine of a generator to produce electricity. In USA and New Zealand, there are several geothermal plants working successfully.

Biomass Energy

Biomass is the biological substance formed by the floras or faunas which contain wood, crop residues, cattle dung, manure, sewage, agricultural wastes, etc. Biomass energy is of the following types:

(a) Energy Plantations: Solar energy is trapped by green plants through photosynthesis and converted into biomass energy. Fast growing trees like cottonwood, poplar and Leucaena, non-woody herbaceous grasses, crop plants like sugarcane, sweet sorghum and sugar beet, aquatic weeds like water hyacinth and sea weeds and carbohydrate rich potato, cereal, etc. are some of the significant energy plantations. They may produce energy either by burning directly or by getting converted into burnable gas or may be converted into fuels by fermentation.

(b) Petro-Crops: Certain latex-containing plants like *Euphorbias* and oil palms are rich in hydrocarbons, and can yield an oil like substance under high temperature and pressure. This oily material may be burned in diesel engines directly or may be refined to form gasoline. These floras are generally recognized as petro-crops.

(c) Agricultural and Urban Waste Biomass: Crop residues, bagasse (sugarcane residues), coconut shells, peanut hulls, cotton stalks, etc. are some of the usual farming waste matters which create energy by burning. Animal dung, fishery and poultry waste, and even human refuse are examples of biomass energy. In Brazil, 30% of electricity is obtained from burning bagasse. In rural India, animal dung cakes are burnt to produce heat. About

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80% of rural heat energy necessities are fulfilled by burning farming waste matters, wood and animal dung cakes.

In rural areas, these forms of waste biomass are burned in open furnaces called **'Chulhas'** which typically generate fume and are not so effective (efficiency is < 8%). Now, improved Chulhas with tall chimney have been designed which have improved effectiveness and are smokeless.

The burning of plant residence or animal wastes cause air pollution and produce a lot of ash as waste residue. The burning of dung destroys essential nutrients like N and P. It is therefore, more useful to convert the biomass into biogas or bio fuels.

Biogas

Biogas is a combination of methane, carbon dioxide, hydrogen and hydrogen sulphide, the main component being methane. Biogas is formed by anaerobiotic deprivation of fauna waste matters (sometimes plant wastes) in the existence of water. Anaerobiotic deprivation means breakdown of biological substance by microorganisms in the non-appearance of oxygen.

Biogas is a non-contaminating, pure and cost-effective fuel which is extremely beneficial for rural areas where a lot of fauna waste matters and farming waste matters are obtainable. India has the major livestock inhabitants in the world (240 million) and has incredible probabilities for biogas creation. From cattle dung alone, we can produce biogas of a magnitude of 22,500 mm^3 annually. A sixty cubic feet gobar gas plant can serve the needs of one average family.

Biogas has the following main advantages: It is pure, non-contaminating and inexpensive. There is direct supply of gas from the plant and there is no storage problem. The mud leftover is a rich fertilizer comprising microbial biomass with most of the nutrients conserved as such. Air-tight digestion/degradation of the animal wastes is safe as it eliminates well-being dangers which usually happen in case of direct use of dung due to direct exposure to faecal pathogens and parasites.

Biogas plants used in our country are basically of two types:

(i) Floating gas-holder type and

(ii) Fixed-dome type.

(i) Floating Gas-holder Type Biogas Plant: This type has a well-shaped digester tank which is placed under the ground and made up of bricks. In the digester tank, over the dung slurry, an inverted steel drum floats to hold the biogas produced. The gas-holder can move which is controlled by a pipe and the gas outlet is regulated by a valve. The digester tank has a partition wall and one side of it receives the dung-water mixture through inlet pipe while the other side discharges the spent slurry through outlet pipe [Fig. 2.5(a)].

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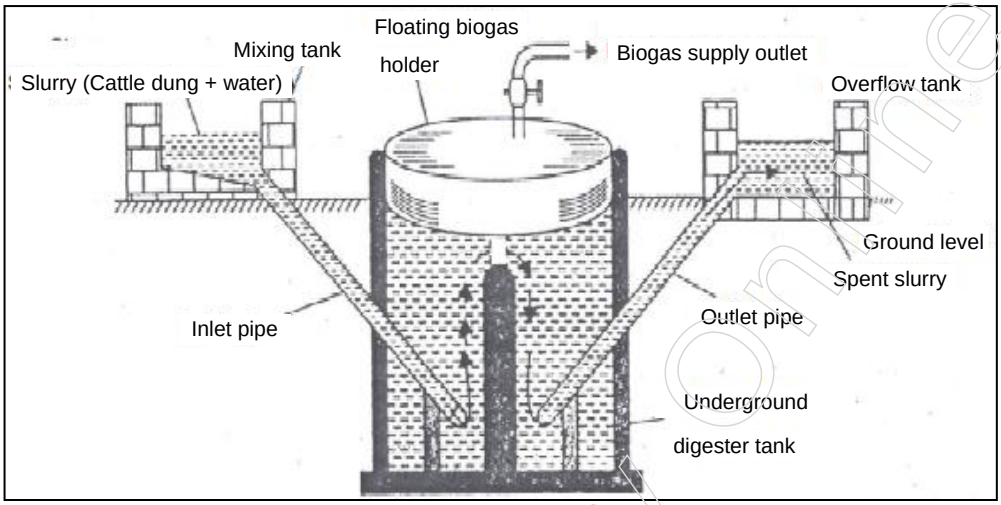

Fig. 2.5(a): Fixed Gas-holder Type Biogas Plant

Occasionally, erosion of steel gas-holder causes seepage of biogas. The tank has to be painted time, and again for conservation which upsurges the price. Hence, another type was designed as discussed below:

(ii) Fixed-Dome Type Biogas Plant: The structure is almost similar to that of the previous type. However, instead of a steel gas-holder, there is dome-shaped roof made of cement and bricks. Instead of partitioning, here there is a single unit in the main digester, but it has inlet and outlet chambers as shown in Fig. 2.5(b).

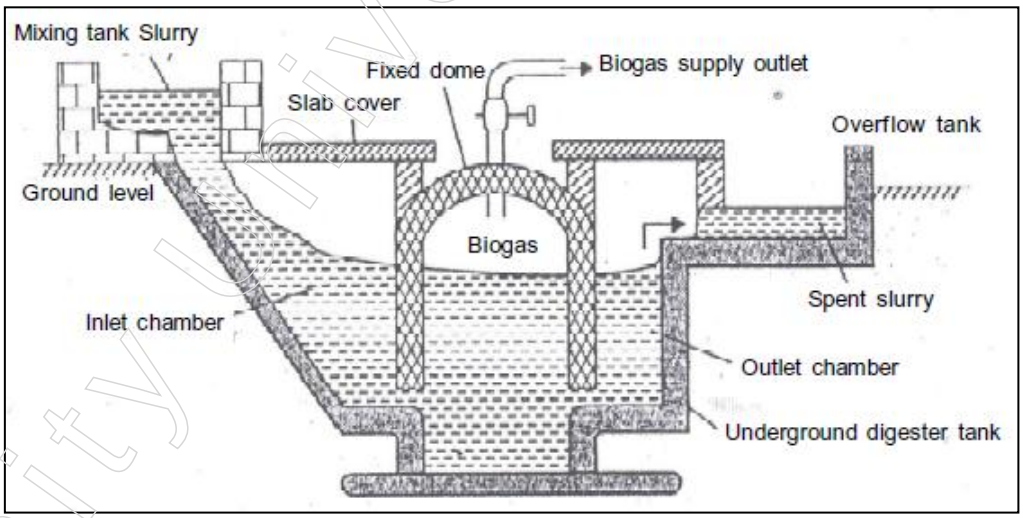

Fig. 2.5(b): Fixed-dome Type Biogas Plant

The Ministry of Non-Conventional Energy Sources (MNES) has been promoting the Biogas Program in India. Out of the numerous representations, the significant ones used in rural setup are KVIC Model (Floating drum type), Janta Model (Fixed dome type), Deenbandhu Model (Fixed dome type), Pragati Model (floating drum type), Ganesh Model (KVIC type but made of bamboo and polythene sheet) and Ferro-cement digester Model (KVIC type with ferro-cement digester).

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Biofuels

Biomass can be fermented to alcohols like ethanol and methanol which can be used as fuels. Ethanol can be easily produced from carbohydrate rich substances like sugarcane. It burns pure and non-contaminating. However, as compared to petrol, its calorific value is less and therefore, produces much less heat than petrol.

Gasohol is a common fuel used in Brazil and Zimbabwe for running cars and buses. In India too, gasohol is planned to be used on trial basis in some parts of the country, to start within Kanpur. Gasohol is a mixture of ethanol and gasoline.

Methanol is very useful since it burns at a lower temperature than gasoline or diesel. Thus, the bulky radiator may be substituted by sleek designs in our cars. Methanol, too, is a pure and non-contaminating fuel.

Methanol can be effortlessly gained from woody plants and ethanol from grain-based or sugar-containing plants.

Hydrogen as a Fuel

As hydrogen burns in air, it associates with oxygen to form water and a huge quantity of energy (150 kilojoules per gram) is emitted. Because of the highest calorific value, hydrogen can help as a brilliant fuel. Furthermore, it is pure and non-contaminating and can be effortlessly formed. Production of hydrogen is possible by thermal dissociation, photolysis or electrolysis of water.

By thermal dissociation of water (at 3000° K or above), hydrogen (H_2) is produced.

Thermochemically, hydrogen is produced by chemical reaction of water with some other chemicals in 2-3 cycles so that we do not need the high temperatures as in direct thermal method and ultimately H_2 is produced.

Electrolytic method dissociates water into hydrogen (H_2) and oxygen by making a current flow through it.

Photolysis of water involves breakdown of water in the existence of sunrays to emit hydrogen. Green plants also have photolysis of water during photosynthesis. Efforts are underway to trap hydrogen molecule which is produced during photosynthesis.

However, hydrogen is highly inflammable and explosive in nature. Hence, cautious management is mandatory for using it as a fuel. Also, it is problematic to stock up and transport. And being very light, it would have to be stored in bulk.

Presently, H_2 is used in the form of liquid hydrogen as a fuel in spaceships.

2. Non-Renewable Energy Resources

These are the fossil fuels like coal, petroleum, natural gas and nuclear fuels. These were created by the disintegration of the leftovers of floras and faunas buried under the earth millions of years ago. The fuels are valuable because they have taken such a long time to be formed and if we consume their reserves at such a fast rate, as we have been doing ever since we discovered them, then very soon we will lose these resources forever.

Coal

Coal was formed 255-350 million years ago in the hot, damp regions of the earth during the carboniferous age. The ancient plants along the banks of rivers and swamps were buried after death into the soil and due to the heat and compression slowly got transformed into peat and coal over millions of years of time. There are mainly three types of coal, namely ***anthracite*** (hard coal), ***bituminous*** (soft coal) and ***lignite*** (brown

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coal). Anthracite coal has maximum carbon (90%) and calorific value (8700 Kcal/kg) Bituminous, lignite and peat contain 80%, 70% and 60% carbon, respectively. Coal is the most plentiful remnant fuel in the world. ***At the present rate of usage, the coal reserves are likely to last for about 200 years and if its use increases by 2% per year, then it will last for another 65 years.***

India has about 5% of world's coal and Indian coal is not very good in terms of heat capacity. Major coal fields in India are Raniganj, Jharia, Bokaro, Singrauli and Godavari valley. The coal states of India are Jharkhand, Orissa, West Bengal, Madhya Pradesh, Andhra Pradesh and Maharashtra. Anthracite coal occurs only in Jammu & Kashmir.

When coal is burnt, it produces carbon dioxide which is a greenhouse gas responsible for causing extreme global warming. Coal also covers scums like sulphur and therefore as it burns the smoke contains toxic gases like oxides of sulphur and nitrogen.

Petroleum

It is the lifeline of global economy. There are **13 countries in the world having 67% of the petroleum reserves** which together form the OPEC (Organization of Petroleum Exporting Countries). About 1/4th of the oil reserves is in Saudi Arabia.

At the current amount of consumption, the world's crude oil reserves are estimated to get exhausted in just 40 years. Some optimists, however, believe that there are some yet undiscovered reserves. Even then the crude oil reserves will last for another 40 years or so. Crude petroleum is a complex mixture of alkane hydrocarbons. Hence, it has to be cleansed and advanced by the procedure of *fractional distillation,* during which process diverse elements detached out at dissimilar temperatures. We get an immense diversity of foodstuffs from this, namely, petroleum gas, kerosene, petrol, diesel, fuel oil, lubricating oil, paraffin wax, asphalt, plastic, etc.

Petroleum is a cleaner fuel as compared to coal as it burns completely and leaves no residue. It is also easier to transport and use. That is the reason why petroleum is preferred amongst all the fossil fuels.

Liquefied Petroleum Gas (LPG): The main component of petroleum is butane, the other being propane and ethane. The petroleum gas is easily converted to liquid form under pressure as LPG. It is odorless, but the LPG in our domestic gas cylinders gives a foul smell. This is, in fact, due to ethyl mercaptan, a foul-smelling gas, added to LPG so that any leakage of LPG from the cylinder can be detected immediately.

Oil fields in India are located at Digboi (Assam), Gujarat Plains and Bombay High, offshore areas in deltaic coasts of Godavari, Krishna, Kaveri and Mahanadi.

Natural Gas

It is mainly composed of methane (95%) with small amounts of propane and ethane. It is a fossil fuel. Natural gas deposits mostly accompany oil deposits because it has been formed by decomposing remains of dead animals and plants buried under the earth. **Natural gas is the cleanest fossil fuel.** It can be easily transported through pipelines. It has a high calorific value of about 50 KJ/G and burns without any smoke.

Currently, the amount of natural gas deposits in the world are of the order of 80,450 gnr^3. Russia has maximum reserves (40%), followed by Iran (14%) and USA (7%). Natural gas reserves are found in association with all the oil fields in India. Some new gas fields have been found in Tripura, Jaisalmer, offshore area of Mumbai and the Krishna Godavari Delta.

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Natural gas is used as a domestic and industrial fuel. It is used as a fuel notes in thermal power plants for generating electricity. It is used as a source of hydrogen gas in fertilizer industry and as a source of carbon in tyre industry.

Compressed Natural Gas (CNG): It is being used as a substitute to petrol and diesel for transport of vehicles. Delhi has totally switched over to CNG where buses and autorickshaws run on this new fuel. CNG use has significantly decreased automobile contamination in the city.

Synthetic Natural Gas (SNG): It is a combination of carbon monoxide and hydrogen. It is a joining link between a remnant fuel and substituted natural gas. Low grade coal is originally altered into artificial gas by gasification followed by catalytic conversion to methane.

Nuclear Energy

Nuclear energy is known for its high damaging power as showed from nuclear weapons. The nuclear energy can also be connected for offering marketable energy. Nuclear energy can be produced by two types of reactions:

(i) Nuclear Fission: It is the nuclear change in which nucleus of certain isotopes with large mass numbers are split into lighter nuclei on bombardment by neutrons and a large amount of energy is released through a chain reaction as shown:

$$_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{36}Kr^{92} + {}_{56}Ba^{141} + 3\ {}_{0}n^{1} + \text{Energy}$$

Nuclear Reactors make use of nuclear chain reaction. In order to control the rate of fission, only 1 neutron released is allowed to strike for splitting another nucleus. Uranium 235 nuclei are most commonly used in nuclear reactors.

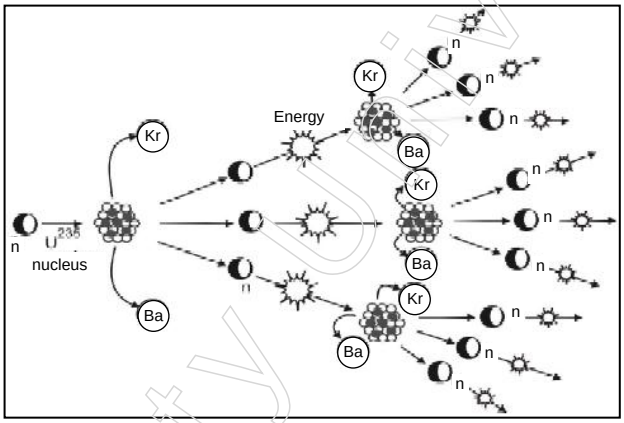

Fig. 2.6(a): Nuclear fission – a reaction initiated by one neutron that bombards a Uranium (U^{235}) nuclei, releasing a huge quantity of energy, two smaller nuclei (Ba, Kr) and 3 neutrons.

(ii) Nuclear Fusion: Here, two isotopes of a light element are forced together at extremely high temperatures (1 billion°C) until they fuse to form a heavier nucleus releasing enormous energy in the process. It is difficult to initiate the process, but it releases more energy than nuclear fission.

$$_{1}H^{2} + {}_{1}H^{2} \rightarrow {}_{3}He^{2} + {}_{0}n^{1} + \text{Energy}$$

Two Hydrogen-2 (Deuterium) atoms may fuse to form the nucleus of Helium at 1 billion°C and release a huge amount of energy. Nuclear fusion reaction can also take place between one Hydrogen-2 (Deuterium) and one Hydrogen-3

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(Tritium) nucleus at 100 million°C forming Helium-4 nucleus, one neutron and a huge amount of energy.

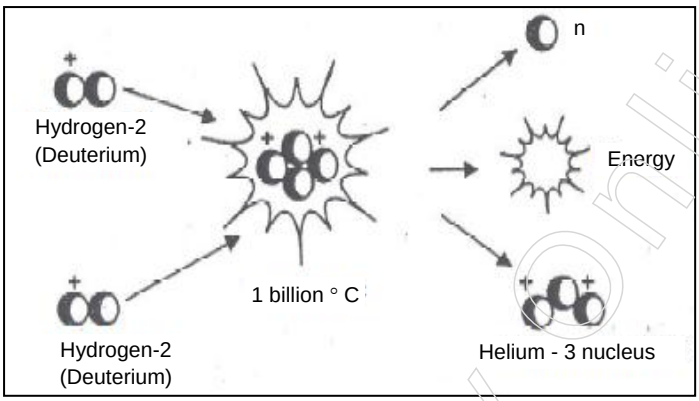

Fig. 2.6(b): Nuclear Fusion : (a reaction between two hydrogen-2 nuclei, which take place at a very high temperature of 1 billion degree centigrade; one neutron and one fusion nucleus of helium-3 is formed along with a huge amount of energy)

Nuclear energy has incredible probabilities, but any seepage from the reactor may cause disturbing nuclear contamination. Disposal of the nuclear waste is also a big problem.

Nuclear power in India is still not very well developed. There are four nuclear power stations with an installed capacity of 2005 MW. These are located at Tarapur (Maharashtra), Rana Pratap Sagar near Kota (Rajasthan), Kalpakkam (Tamil Nadu) and Narora (Uttar Pradesh).

2.7 Land Resources

Land as a Resource: Landscapes like mountains, valleys, grasslands, river basins and wetlands consist of dissimilar resource-generating zones that the people living in them depend on. Many old-style agricultural groups had ways of conserving zones from which they used resources. For example, in the 'sacred groves' of the Western Ghats, requests to the spirit of the grove for permission to cut a tree, or extract a resource were accompanied by simple rituals. The consequence of a chance fall on one side or the other of a stone balanced on a rock gave or suspended authorization. The request could not be repeated for a stated period.

If land is utilized carefully, it can be considered a renewable resource.

The roots of trees and grasses bind the soil. If woodlands are exhausted, or plains overgrazed, the land becomes fruitless and wasteland is formed. Intensive irrigation leads to water-logged and salinized soil, on which crops cannot grow. Land is also converted into a non-renewable resource when highly-toxic manufacturing and atomic wastes are dumped on it. Land on Earth is as finite as any of our other natural resources. While mankind has learnt to adapt his lifestyle to numerous ecologies over the world, he cannot live securely, for instance, on polar ice caps, under the sea, or in space in the predictable future.

Man needs land for constructing households, cultivating food, preserving grasslands for domestic animals, emerging businesses to offer products, and backing up the businesses by making cities and metropolises. Prominently, man requires to defend

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wildlife parts in woodlands, plains, swamplands, foothills, shorelines, etc. to guard our disparagingly valued biodiversity.

Thus, a rational use of land needs careful planning. One can develop most of these different types of land uses almost anywhere, but Protected Areas (national parks and wildlife sanctuaries) can only be situated where some of the natural ecosystems are still undisturbed. These PAs are important aspects of good land use planning.

Land Degradation: Farmland is under threat due to more and more intense utilization. Every year, between 5-7 m ha of land worldwide is added to the existing degraded farmland. When soil is used more intensively by farming, it is eroded even more rapidly by wind and rain. Overirrigating farmland leads to salinization, as the evaporation of water brings the salts to the surface of the soil on which crops cannot grow. Overirrigation also creates water logging of the topsoil so that crop roots are affected and the crop deteriorates. The use of more and more chemical fertilizers poisons the soil and ultimately the land turns out to be fruitless.

As city centers grow and manufacturing development arises, the farming property and woodlands shrinks. This is a severe damage and will have undesirable lasting impacts on human societies.

Case Study

Selenium: Punjab (Selenium in Soil): In 1981-82, farmers from Hoshiarpur and Nawanshehar Districts approached the scientists in the Punjab Agricultural University (PAU), Ludhiana, as their wheat crops had turned white. Soil analysis indicated selenium (Se) levels in the area were above toxic limits. See is a naturally-occurring trace element, essential for animal and human health, but the gap between the requirement and excess is narrow. Soils containing 0.5 µg of Se per kg or more are injurious to health. In some areas of Punjab, Se levels range from 0.31 µg/kg to 4.55 µg/kg. Rice cultivation requires the presence of standing water. Being highly soluble, Se dissolves and comes to the surface; the water then evaporates leaving the Se behind.

Soil Erosion: The features of natural ecosystems like woodlands and plains rely on the kind of soil. Soils of numerous kinds sustain an extensive diversity of harvests. The mismanagement of an ecology results in damage of valued soil through corrosion by the monsoon rains and, to a smaller extent, by wind. The roots of the trees in the forest hold the soil. Desertification thus causes to fast soil corrosion. Soil is washed away into streams, transported into rivers and finally lost to the sea. The procedure is more noticeable in parts where desertification has caused corrosion on steep hill slopes as in the Himalayas and in the Western Ghats. These areas are called 'ecologically sensitive areas' or ESAs. To prevent the loss of millions of tons of valuable soil every year, it is vital to reserve our natural forest cover. It is equally important to reforest denuded areas. The link between the existence of forests and the presence of soil is greater than the forest's physical soil binding function alone. The soil is enriched by the leaf-litter of the forest. This detritus is broken down by soil microorganisms, fungi, worms and insects, which help to recycle nutrients in the system. Further, losses of our soil wealth will deprive our country and reduce its capacity to grow enough food in future.

Desertification

Desertification process is leading to desert formation. This may result either due to a natural phenomenon linked to climatic change or due to abusive land use.

It is known that deforestation, overgrazing etc. Bring about changes in rainfall, temperature, wind velocity etc. And also lead to soil erosion. Such changes then lead to desertification of the area. Desertification often starts as patchy destruction of productive

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land. Increased dust particles in atmosphere lead to desertification and drought in margins of the zones that are not humid. Even the humid zones are in danger of getting progressively drier if droughts continue to occur over a series of years. This trend is not restricted to the fringes of existing deserts only. The threat of desertification is thus real, because as the forest diminishes, there is steady rise in the atmospheric temperature.

There is no denying that during the past two decades, there has increased damage to forests and other ecosystems by man. At the time of independence in the country, 75 million hectares, about 22% was under forest cover. Today this has been reduced to just over 10% India has been losing 10 million trees every 24 hours. Thus deforestation is one of the main factors leading to desertification, primarily through its effect on climate of the area.

As a result of gross mismanagement of natural resources including land, certain irreversible changes have triggered the breakdown of nutrient cycles and microclimatic equilibrium in the soil indicating the onest of desertic conditions. The once verdant Kumaon hills are on their way of degeneration. The mountain springs have dried up or become seasonal with substantial reduction in the flow of rivers and streams. The deforestation in the Himalayas linked to population explosion. Stress on revenue earning and resources regeneration for pulp and match industries seems to have accelerated soil erosion. Resin tapping from chirpine trees has choked the trees to death, causing premature death of trees by uprooting and windfall.

Impact of Drought

The impact of drought on the socio-cultural milieu is significant. The most obvious adverse impact is felt on the health of cattle and human population of the affected area. Water scarcity results in a higher incidence of water diseases. And while drought is temporary phenomenon, desertification is not.

The chief causes of desertification are (i) climatic factors, (ii) human factors (human cultures.) Recent changes in land use and population density had much ecological effects. Human factors are population growth and increased density, reduced nomadism and loss of grazing lands, (iii) interactions between climate and culture.

The causes of deforestation and denudation are well known. The principal causes have been the population explosion in man ans livestock leading to enhanced requirement of timber and fuelwood, and grazing respectively. Increasing number of livestock and migrating graziers contributes to degradation of forests and the consequent to devastation. The most accessible forest areas are heavily grazed. For instance, there are nearly 1200 thousand sheeps and goats in alpine areas of U.P and in addition there also visit about 25,000 migratory graziers. There are also about 5-7,000 buffaloes owned by Gujaras.

Existing forests may not be able to meet our wood and fodder requirements of mankind and livestock respectively.

Moreover, increase in shifting (jhum) cultivation in North east and Orissa has also laid large forest tracts bare. In essence, it is a low energy budget and low investment system of subsistence agriculture that uses rapid mineralization and recycling of nutrents. There has been shortening of jhum cycle to six years only (in some districts, even 2-3 years only), which provides no enough time for natural repair of damages ecosystem.

2.8 Role of an Individual in Conservation of Natural Resources

Until lately, mankind represented as if he could infinitely exploit the Earth's ecologies and natural resources like soil, water, woodlands and plains and extract

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reserves and remnant fuels. However, in the last few decades, it has become progressively obvious that the global ecology has the capacity to withstand only a partial stage of utilization. Organic structures cannot go on refilling supplies if they are overused or misused. At a critical point, increasing pressure destabilizes their natural balance. Even biological resources traditionally classified as 'renewable' such as those from our oceans, woodlands, plains and swamplands – are being degraded by overuse and may be entirely devastated. And no natural resource is limitless. Non-renewable resources will be quickly diminished if we continue to use them as intensively as at present.

The two greatest harmful issues causing the present fast exhaustion of all life-forms of natural assets are growing 'consumerism' on the part of the wealthy sections of society, and speedy inhabitants' development. Both issues are the consequences of selections we make as people. As people, it is essential we choose the right option.

What will we leave to our children? (Are we thinking of short-term or long-term gain?) Is my material gain someone else's loss?

In general, acquisitiveness has become a way of life for a majority of people in the developed world. Population growth and the subsequent scarcity of resources most severely disturb people in the developing nations. In countries such as ours, which are both developing rapidly and suffering from a population explosion, both factors are responsible for ecological deprivation. We must ask ourselves if we have possibly touched a dangerous crisis, at which economic 'development' affects the lives of people more unfavorably than the profits it offers.

A pressure cooker can save up to 75% of the energy required for cooking. It is also faster. Keeping the vessel covered with a lid during cooking, helps to cook faster, thus saving energy.

Reducing the unmanageable and inadequate use of resources, and controlling our population growth are important for the survival of our nation and indeed, of humankind everywhere. Our environment offers us with a diversity of goods and services essential for our day-to-day lives, but the soil, water, climate and solar energy, which form the 'abiotic' support that we derive from nature, are in themselves not distributed evenly throughout the world or within countries. A new economic order at the global and at national levels must be based on the countries as well as among communities within countries such as our own. It is at the local level where people survive by the sale of locally-collected resource, that the inequality is greatest. 'Development' has not reached them and they are often unfairly accused of 'exploiting' natural resources. They must be sufficiently remunerated for the removal of the sources to distant regions and thus develop a greater stake in protecting natural resources.

There are several principles that each of us can adopt to bring about sustainable lifestyles. This primarily comes from caring for our Mother Earth in all respects. A love and respect for nature is the utmost sentiment that helps bring about a feeling for looking at how we use natural resources in a new and sensitive way. Think of the beauty of a wilderness, a natural forest in all its splendor, the expanse of a green grassland, the clean water of a lake that supports so much life, the crystal-clear water of a hill-stream or the magnificent power of the oceans and we cannot help but support the preservation of nature's wealth. If we respect this, we cannot commit acts that will exhaust our life-supporting systems.

Different natural resources like forests, water, soil, food, mineral and energy resources play a vital role in the development of a nation. However, overuse of these resources in our modern society is resulting in fast reduction of these resources and

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several problems. If we want our mankind to flourish, there is a strong need to conserve these natural resources.

While conservation efforts are underway at national as well as international level, the individual efforts for conservation of natural resources can go a long way. Environment belongs to each one of us and all of us have a responsibility to contribute towards its conservation and protection. “Small droplets of water together form a big ocean”. Similarly, with our small individual efforts, we can together help in conserving our natural resources to a large extent. Let us see how can individuals help in conservation of different resources.

Conserve Water

- Don’t keep water taps running while brushing, shaving, washing or bathing.
- In washing machines, fill the machine only to the level required for your clothes.
- Install water-saving toilets that use not more than 6 litres per flush.
- Check for water leaks in pipes and toilets and repair them promptly. A small pin-hole sized leak will lead to the wastage of 640 litres of water in a month.
- Reuse the soapy water of washings from clothes for washing-off the courtyards, driveways, etc.
- Water the plants in your kitchen-garden and the lawns in the evening when evaporation losses are minimum. Never water the plants in mid-day. Use drip irrigation and sprinkling irrigation to improve irrigation efficiency and reduce evaporation.
- Install a small system to capture rain water and collect normally wasted used water from sinks, cloth-washers, bath-tubs, etc. which can be used for watering the plants.
- Build rainwater harvesting system in your house. Even the President of India is doing this.

Conserve Energy

- Turn off lights, fans and other appliances when not in use. Obtain as much heat as possible from natural sources. Dry the clothes in sun instead of drier if it is a sunny day. Use solar cooker for cooking your food on sunny days which will be more nutritious and will cut down on your LPG expenses.
- Build your house with provision for sunspace which will keep your house warmer and will provide more light.
- Grow deciduous trees and climbers at proper places outside your home to cut off intense heat of summers and get a cool breeze and shade. This will cut off your electricity charges on coolers and air-conditioners. A big tree is estimated to have a cooling effect equivalent to five air conditioners. The deciduous trees shed their leaves in winter. Therefore, they do not put any hindrance to the sunlight and heat.
- Drive less, make fewer trips and use public transportations whenever possible. You can share by joining a car-pool if you regularly have to go to the same place.
- Add more insulation to your house. During winter, close the windows at night. During summer, close the windows during days if using an AC. Otherwise, loss of heat would be more, consuming more electricity.
- Instead of using the heat convector more, often wear adequate woollens.

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- Recycle and reuse glass, metals and paper.
- Try riding bicycle or just walk down small distances instead of using your car or scooter.
- Lower the cooling load on an air conditioner by increasing the thermostat setting as 3-5% electricity is saved for every one degree rise in temperature setting.

Protect the Soil

- While constructing your house, do not uproot the trees as far as possible. Plant the disturbed areas with a fast-growing native ground cover.
- Grow different types of ornamental plants, herbs and trees in your garden. Grow grass in the open areas which will bind the soil and prevent its erosion.
- Make compost from your kitchen waste and use it for your kitchen-garden or flower-pots.
- Do not irrigate the plants using a strong flow of water, as it would wash off the soil.
- Better use sprinkling irrigation.
- Use green manure and mulch in the garden and kitchen-garden which will protect the soil.
- If you own agricultural fields, do not overirrigate your fields without proper drainage to prevent water logging and salinization.
- Use mixed cropping so that some specific soil nutrients do not get depleted.

Promote Sustainable Agriculture

- Do not waste food. Take as much as you can eat.
- Reduce the use of pesticides.
- Fertilize your crop primarily with organic fertilizers.
- Use drip irrigation to water the crops.
- Eat local and seasonal vegetables. This saves lot of energy on transport, storage and preservation.
- Control pests by a combination of cultivation and biological control methods.

2.9 Equitable Uses of Resources for Sustainable Lifestyles

There is a big divide in the world as North and South, the More Developed Countries (MDCs) and Less Developed Countries (LDCs), 'the have's' and 'the have not's'. The less developed does not mean that they are backward as such, they are culturally very rich or even much more developed, but economically they are less developed. The gap between the two is mainly because of population and resources.

The MDCs have only 22% of world's population, but they use 88% of its natural resources, 73% of its energy and command 85% of its income. In turn, they contribute a very big proportion to its pollution. These countries include USA, Canada, Japan, the CIS, Australia, New Zealand and Western European Countries. The LDCs, on the other hand, have very low or moderate industrial growth, have 78% of the world's population and use about 12% of natural resources and 27% of energy. Their income is merely 15% of global income. The gap between the two is increasing with time due to sharp increase in population in the LDCs. The rich have grown richer while the poor have stayed poor or gone even poorer.

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As the rich nations are developing more, they are also leading to more pollution and sustainability of the earth's life support system is under -threat. The poor nations, on the other hand, are still struggling hard with their large population and poverty problems. Their share of resources is too little leading to unsustainability.

As the rich nations continue to grow, they will reach a limit. If they have a growth rate of 10% every year, they will show 1024 times increase in the next 70 years. Thus, the solution to this problem is to have more equitable distribution of resources and wealth. We cannot expect the poor countries to stop growth in order to check pollution because development brings employment and the main problem of these countries is to tackle poverty. All the natural resources have to be equally distributed to fulfil demands of nourishing food, clean drinkable water and shelter of humans and natural habitats floras and faunas must be guarded.

Thus, the two basic causes of unsustainability are overpopulation in poor countries who have underconsumption and overconsumption of resources by the rich countries, which generate wastes. In order to achieve sustainable lifestyles, it is desirable to achieve a more balanced and equitable distribution of global resources and income to meet everyone's basic needs.

The rich countries will have to lower down their consumption levels while the bare minimum needs of the poor have to be fulfilled by providing them resources. A fairer sharing of resources will narrow down the gap between the rich and the poor and will lead to sustainable development for all and not just for a privileged group.

2.10 Environmental Implications of Non-Conventional Sources of Energy

The sources like solar, wind, tidal, ocean and biomass are renewable. Many of these sources are still in their infant stages and require a lot of R&D efforts. The use of **solar energy** is a completely benevolent operation. Cadmium is used in fabricating thin film solar cells which is both poisonous and carcinogenic. But, a very small quantity of cadmium is released from discarded PV panels. **Carbon dioxide** produced while forming silicon from silica increases atmospheric temperature.

2.11 Role of Government

The Government with the Central and State Pollution Control Boards and various agencies such as Central Electricity Authority (CEA), Confederation of Indian Industry (CXI), National Productivity Council (NPC), National Environment Engineering Research Institute (NEERI), Department of Atomic Energy (DAE) and Tata Energy Research Institute (TERI) must evolve comprehensive programmes on environment and announce a legislation covering the following basic aspects.

- Cost-effective cleaner air technology with fiscal incentives.
- Mandatory energy audits.
- Increased use of renewable sources of energy such as biomass and industrial plant wastes, energy efficient environment-friendly technologies and a comprehensive integrated environmental planning.
- Afforestation contributing to biological diversity and integration of agricultural and environmental policies.
- Promotion of public awareness through dissemination of information on ill-effects of certain chemicals. Polluter pays policy along with a tradeable pollution tax.

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- Punitive measures on pollution non-compliance and scientific environment policy codes and efficient standards.
- Renovation and replacement of ageing boilers with established combustion technologies.

The government should spell out the fiscal benefits for those industries committed to this noble cause of cleaner air and must come down heavily on environment offenders.

2.12 Summary

The forthcoming in the arena of energy is full of challenges demanding a lot of ingenuity. Although the availability and cost of different kinds of energy have a direct effect on the economic and social development of a nation, the choice of energy type depends on a number of factors. For example, non-renewable resources being small in quantity Ladakh, geothermic energy can be an alternative. In Andaman and Nicobar Islands, ocean and tidal energy must demonstrate a feasible basis of energy. For nuclear energy, we should concentrate on the efficient use of plutonium and thorium.

The assets of oil and natural gas are inadequate. So, R&D for the utilization of renewable sources should be organized and strengthened. Cleaner technologies can help to lessen the greenhouse effect. India has a vast potential for renewable sources of energy but their commercial exploitation is minimum. If energy consumption continues to grow with the growth of population, it will be difficult to keep pace with the growing power demands even with massive installations of solar and other alternative sources.

The Government of India, in its Tenth Five Year Plan, laid down the following policy:

It is imperative that we sensibly utilize our renewable resources of soil, water, plant and animal life to sustain our economic development. Excessive consumption of these is replicated in soil corrosion, siltation, inundations, fast devastation of woodland, flowery and wildlife assets. The exhaustion of these supplies frequently has a tendency to be unalterable as the majority of inhabitants hinge on to these properties for their elementary requirements. Since earth does not belong to man but man belongs to the earth, so conservation of energy is essential for economic growth and environmental protection.

Any material which is required or used to sustain life or livelihood is termed as resource. The progress and expansion of a nation hinges on the obtainability of these properties. Largely, they can be categorized as non-conventional and conventional resources or substitute resources. In order to create awareness and protect our valuable resources for a longer period of time, there were movements time and again, such as ‘Chipko’, ‘Appiko’, etc. It is imperative that we carefully utilize the sources that have been given by nature.

2.13 Check Your Progress

I. Multiple Choice Questions

1. Metal is _____.
   (a) Inorganic resource
   (b) Organic resource
   (c) Man-made resource
   (d) Biotic resource

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2. _____ is inexhaustible resource.
   (a) Solar energy
   (b) Iron mineral
   (c) Copper
   (d) Mineral oil
3. Minerals are _____.
   (a) Man-made resources
   (b) Biological resources
   (c) Exhaustible resources
   (d) Inexhaustible resources
4. Which of the following is non-convectional energy source?
   (a) Wind energy
   (b) Electricity
   (c) Mineral oil
   (d) Coal
5. The source of which resources are continuous are called as _____.
   (a) Non-exhaustible
   (b) Exhaustible
   (c) Man-made
   (d) Changing

2.14 Questions and Exercises

1. What are the major causes of deforestation?
2. Should we build dams? Discuss.
3. Explain in brief non-conventional and conventional resources.
4. What do you understand by shifting cultivation and eutrophication?
5. Explain the importance of 'Chipko' Movement.

2.15 Key Terms

- **Rainwater Harvesting:** A mechanism to conserve water resource by trapping rainwater and storing it.
- **Deforestation:** Removal of forest cover from an area.
- **Afforestation:** Plantation of fresh woodlands on landscapes that factually has not contained woodlands.
- **Drip Irrigation:** Use of perforated tubes that give water drop-wise to the soil around each plant.
- **Anthropogenic:** Human generated or caused by humans.
- **Eutrophication:** Overnourishment of water bodies due to excessive nutrients.

2.16 Check Your Progress: Answers

I. Multiple Choice Questions

Question	Answer

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1	(a)
2	(a)
3	(c)
4	(a)
5	(a)

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Module II: Ecosystems

Unit III: Ecosystems

Structure:

Objectives

After studying this unit, you should be able to:

- Define and describe perception of an ecosystem
- Comprehend the construction and purpose of ecosystem
- Explain the energy flow in the ecosystem and ecological succession
- Differentiate between food chains, food webs and ecological pyramids
- Describe the type, characteristic features and structures of ecosystems

3.1 Introduction

Ecosystem is a region in which the living organisms interact with their environment. It is also called an ecological system.

Before understanding the concept of ecosystem, it is better to know the various terms associated with it.

Organism: It is a living thing like plant, animal or microorganism (microbe).

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Cell: It is an elementary unit of living thing. It is the smallest independently functioning unit in the structure of an organism. Most organisms have numerous cells. Some are single-celled organisms like bacterium.

Species: It is a set of organisms that resemble each other in appearance and behavior. Organisms of a species are capable of reproducing among themselves and generally organisms of the different species do not interbreed, and even if they do, fertile offspring is not produced.

Population: When members of the same species live and interact in a specific topographical zone, they are called population. For example, pine trees in a forest, zebras in grassland, people in a country, etc. Although, there are broad similarities among the members, yet they do not look alike. Members of same species living in separated areas are also considered population.

Community: It is the accumulation of all interacting populations of different species living in one geographical area. Each population plays its role in the community. It becomes a complex interacting network of plants, animals and microorganisms.

Ecosystem: Ecosystem is a community or population of organisms interrelating with one another and with their surrounding environment. The interactions propagate the community to retain stability under varying conditions. A forest, a desert, a lake, etc. are the ecosystems. All the ecosystems of this earth are interlinked and interdependent to make a huge biosphere.

Deep sea hydrothermal ecosystems are exception and depend entirely on the earth's energy and not on sun's energy.

The term was first coined by British Ecologist, Sir Arthur George Tinsley in 1935, who described the ecosystem as natural systems in continuous exchange between their living and non-living parts.

Biosphere: Our earth has three spheres – lithosphere, atmosphere and hydrosphere. **Lithosphere** is the outermost layer of earth that contains soil, fossil fuels and minerals. **Atmosphere** is like an envelope of air around the earth that extends up to 50 km from the surface of earth. Its outer layers extend to more than a thousand km from earth surface. **Troposphere** is the bottom-most layer extending up to 12 km and the **Stratosphere** which contains ozone layer in its upper part extends up to 50 km. The liquid water makes the third sphere, i.e., **Hydrosphere**.

Today's environment endured adequately steady for hundreds of millions of years to sustain the development of current life forms.

Biosphere is the fourth zone of earth. It is relatively a thin zone of land, air and water which is proficient of holding up various life-forms. It extends from a height of 10 km in the atmosphere to the deepest floor of ocean. Sun is the chief source of energy in this sphere.

3.2 Concept of an Ecosystem

Introduction

The word ecosystem was thought by **A.G. Tansley** in 1935, where **eco** indicates the ecologies and **system** means an interrelating, codependent and multifaceted.

Ecology perhaps can be explained as the structure resultant from the incorporation of life forms and inorganic features of the atmosphere.

Therefore, any component that comprises of all creatures, i.e., the societies in a specified zone cooperate with the bodily atmosphere, so that a movement of radiation

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causes to evidently lodged tropical build up, organic variety and substantial rotation (i.e., interchange of resources amongst biological and inorganic elements) inside the structure is identified as an **ecological system or ecosystem (Fig. 3.1)**.

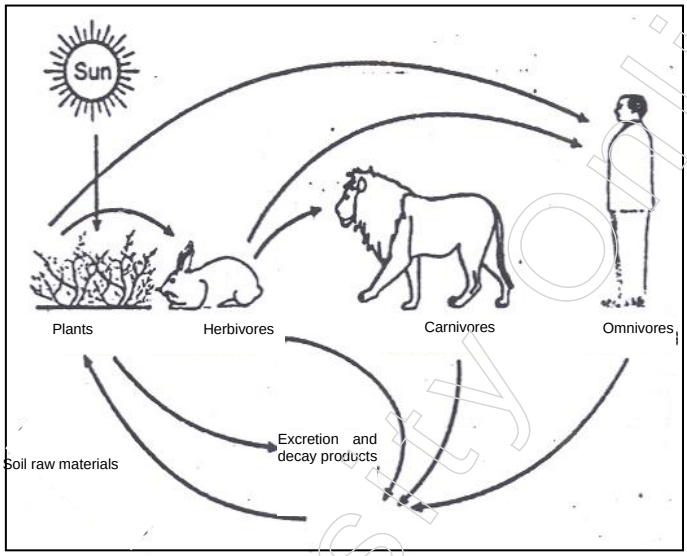

Fig. 3.1: Ecosystem/Ecological System

Earth is an enormous ecology where living and non-living elements are continuously reacting and responding with one another, carrying physical and operational variations in it. This massive ecological environment is split into components of minor ecologies like **earth-bound ecologies** and **marine ecologies**. An ecosystem may be as small as a pond, a cropland or as large as an ocean, desert or forest. These systems are functionally connected with one another establishing a combined structure.

The current growth in environmental lessons also assumes resemblances and modifications in diet and radiation relations between biotic elements that is stated as **bioenergetic approach** in current biology. An ecology is generally an exposed structure with a constant, but flexible, arrival and damage of elements and radiations. It is an elementary, purposeful component with zero restrictions of limits, containing both, living and non-living elements, cooperating with one another. Therefore, an ecology signifies the uppermost stage of environmental amalgamation which is based upon radiation and this useful part is proficient of radiation conversion, buildup and movement. Its foremost purpose in biological logic is to emphasize mandatory relations, interconnection and unintended relationships.

3.3 Types of Ecosystem

1. **Natural Ecosystems:** These systems function on their own under natural circumstances without any meddling by man. These are further divided into:
   - **(a) Terrestrial ecosystem** consists of woodlands, plains and desert, etc.
   - **(b) Aquatic ecosystem** may be further segregated as:
     - **(i) Fresh water**, which may be lotic (running water as spring, stream or rivers) or lunatic (standing water as lake, pond, pools, ditch, puddles, swamp, etc.).
     - **(ii) Marine water** such as ocean (deep bodies) or sea or estuary (shallow ones).

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2. **Artificial (Man-engineered) Ecosystems:** These are preserved unnaturally by humans where, by adding radiations and strategic managements, natural stability is troubled frequently. For instance, croplands like maze, wheat, rice fields, etc. where humans attempt to regulate the groups of life forms along with the physio-chemical atmosphere are human planned ecologies. There is acknowledgement of few other ecologies, identified as interplanetary bionetwork.

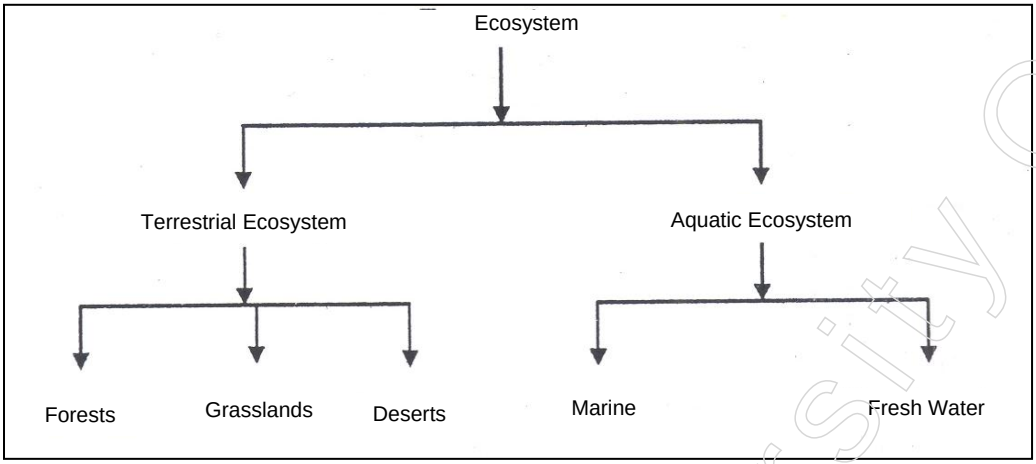

Fig. 3.2: Ecosystem: Classification

3.4 Structure and Function of an Ecosystem

The two main features of a bionetwork are: the structure and function.

By **structure**, we mean:

1. The arrangement of organic community together with breeds, numbers, biomass, life history and distribution in space, etc.
2. The amount and circulation of the abiotic elements like, nutrients, water, etc.
3. The variety, or gradient of situations of survival like temperature, light, etc.

By **function**, we mean:

(a) The rate of biological energy flow, i.e., the production and respiration rates of the community.

(b) Rate of materials or nutrient cycles.

(c) Organic or environmental guideline involving both, rule of creatures by atmosphere (photoperiodism, etc.) and guideline of atmosphere by the creature, (nitrogen fixing organisms, etc.). So, in any ecology, assembly and purpose (rate functions, etc.) are learnt simultaneously.

3.5 Ecosystem Functioning

The functional pattern of every environment is significant to study because all the components are dynamic in nature. There is a constant exchange of matter and energy between organic and inorganic elements. The interdependence between these components is so high that any change in one component brings change into another component and subsequently the changes affect the whole system. The ecosystem functioning can be studied under three heads:

1. Energy Flow

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2. Productivity
3. Biogeochemical Cycling or Nutrient Cycling

1. Energy Flow

The living part of the ecosystem can be best described in terms of feeding levels or trophic levels. At all the levels, there is transfer of energy which is the essence of life. Without the transfer of energy, there could be no life and no ecosystem. Total energy is derived from the sun. Over, earth the energy is neither created nor destroyed.

The sun radiates its energy in all directions. Only a minor portion of it reaches earth which is sufficient to offer energy for all the organic mechanisms of the environment. The energy passes through various trophic levels.

(a) First Trophic Level: This is the first phase of energy flow. In this stage or level, the sunlight is converted into chemical energy. This energy remains stored in the cells. The chemical energy is formed with the help of photosynthesis. In this process, the green plants and planktons use the solar energy to convert carbon dioxide and water into simple sugar glucose. The most important by-product of this process is the oxygen which is used by all organisms. Plants are the first link of the food web. Therefore, they are also called primary producers.

(b) Second Trophic Level: In the second trophic level, many animals and insects feed on the plants. Thus, the radiation is shifted from floras to faunas eating them. In this manner, the radiation is transported from first trophic level to the second trophic level. Animals that obtain their energy solely by eating plants are known as herbivores. They are also called the primary consumers because they are the first to consume energy generated by plants or primary producers.

(c) Third Trophic Level: The third trophic level is made by the animals that feed on the herbivores. Because they are flesh eating animals, therefore they are also called carnivores. In this way, the radiation is moved from the second trophic level to the third trophic level. Animals of this trophic level are called secondary consumers because they are feeding on the herbivores who have already consumed energy from plants.

(d) Fourth Trophic Level: The fourth trophic level is also made up of carnivores. These animals feed on other carnivores. The radiation is shifted from third trophic level to fourth trophic level. Animals of fourth trophic level are called the tertiary consumers.

(e) Fifth Trophic Level: The fifth trophic level is made up of decomposers which include microorganisms like bacteria and fungi. They disintegrate the dead and rotting substance into foods which can be consumed once again. Decomposition of food, in fact, can take place at other trophic levels also. Thus, they are proficient of receiving energy from all types of plants as well as animals. They also supply energy to all the organisms at all levels.

As the trophic level rises, the number of predators decreases, but their size increases. They become more agile.

Loss of Energy during Transfer

When energy is moved from one level to another, only 10% is sent further to the next higher trophic level. Remaining 90% is released into the atmosphere. The primary producers, therefore, receive maximum energy and carnivores at fourth level receive minimum energy. There is continuous decline in the energy as it transfers from one

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trophic level to another throughout the food chain. It means that longer the food chain, lesser the total energy available to the last recipient. This way the food chain cannot be more than five or six levels. Herbivores, therefore, get more energy than the carnivores. *All energy flowing through trophic levels dissipates as heat. At last, the energy loses its capacity to work, a stage known as entropy.*

3.6 Food Chains and Food Webs

The sequence of eating and being eaten in an ecosystem is known as food chain. All creatures, existing or deceased are possible food for other creature and so, there is fundamentally zero waste in the working of a natural ecology. A caterpillar eats a plant leaf, a sparrow eats the caterpillar, a cat or a hawk eats the sparrow and when they all die, they are all consumed by microorganisms like bacteria or fungi (decomposers) which break down the organic substance and change it into simple inorganic materials that can again be used by the plants, who are the primary producers.

Some common illustrations of simple food chains are:

1. Grass grasshopper → Frog → Snake → Hawk (Grassland ecosystem).
2. Phytoplankton → Water Fleas → Small Fish → Tuna (Pond ecosystem).
3. Lichens → Reindeer → Man (Arctic Tundra).

Every creature in the environment is allocated an eating stage reliant on its nutritive position. Hence, in the grassland food chain, grasshopper occupies the first trophic level, frog the second, and snake and hawk occupy the third and the fourth trophic levels, correspondingly. The decaying bacteria eats the deceased substance of all these trophic levels. In nature, we come across two major types of food chains:

1. **Grazing Food Chain:** It starts with green plants (main creators) and concludes in carnivores. All the examples cited above show this type of food chain. Another example could be Grass → Rabbit → Fox.

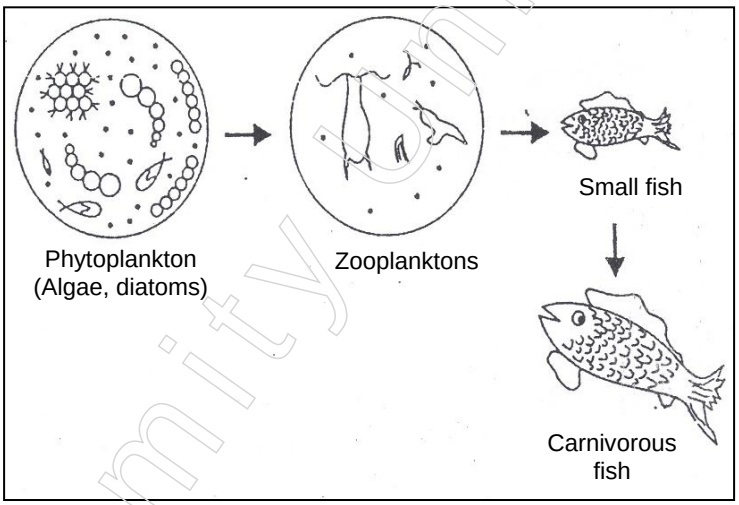

Fig. 3.3: A Grazing Food Chain in a Pond Ecosystem

2. **Detritus Food Chain:** It begins with deceased biological substance which the detritivores and decaying bacteria eat. Partly rotten deceased biological substance the bacteria too are eaten up by detritivores and their predators. An instance of the detritus food chain is seen in a Mangrove (estuary).

   A huge number of leaves falls in the kind of clutter into the water. The leaf fragments are consumed by **Saprotrophs** (These are organisms which feed

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on dead organic matter). These fallen leaves are colonised by small algae. These are also consumed by saprotrophs or detritivores consisting of crabs, mollusks, shrimps, insect larvae, nematodes and fishes. The deritivores are eaten by small carnivorous fishes, which in turn are eaten by large carnivorous fishes.

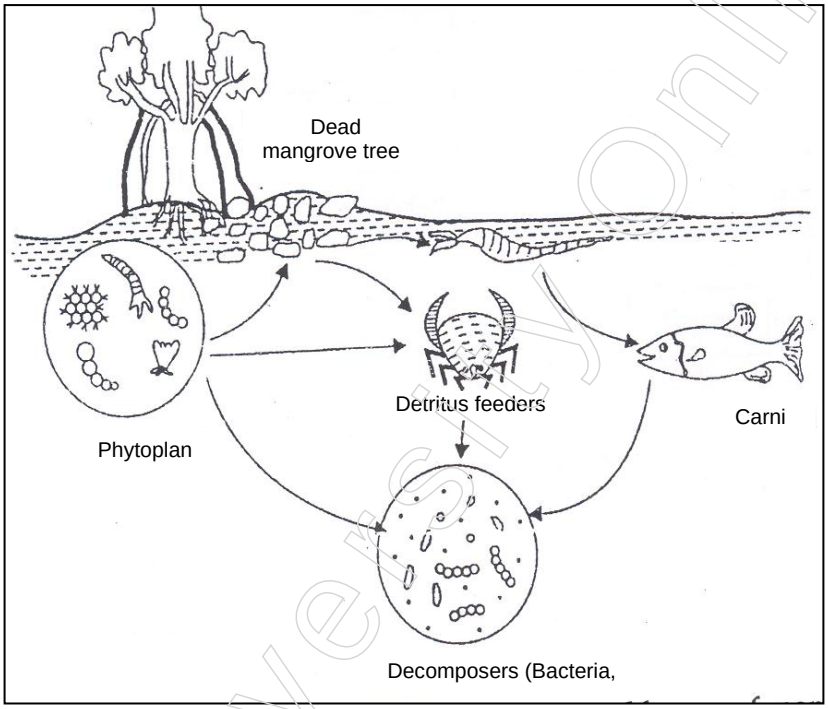

Fig. 3.4: A Detritus Food Chain in an Estuary Based on Dead Leaves of Mangrove Trees

Leaf litter → Algae → Crabs → Small Carnivorous Fish → Large → Carnivorous Fish (Mangrove ecosystem)

Dead Organic Matter → Fungi → Bacteria (Forest ecosystem)

Therefore, the grazing food chain originates its energy essentially from vegetal energy, while in the detritus food chain, it is gained mainly from plant biomass, secondly from bacterial biomass and thirdly from meat-eaters. Both the food chains arise simultaneously in natural ecologies, but grazing food chain typically dominates.

Food Webs

Food chains in ecologies are seldom observed to work as remote lined systems. Instead, they are observed to be unified and typically create a multifaceted net with numerous connections and are recognized as food webs. Hence, **food web is a system of food chains where diverse kinds of creatures are linked at diverse trophic levels, so that there are a many choice of eating and being eaten at each trophic level.**

A food web in the unique Antartic Ecosystem

This is representing the total Ecosystem including the Antartic sea and the continental land. The land does not show any higher life forms of plants. The only species are that of some algae, lichens and mosses. The animals include Penguins and Snow Petrel. They depend upon the aquatic chain for their food energy.

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In a humid area, on the flip side, the ecologies are very multifaceted. They have enriched breeds and varieties. Hence, the food webs are mostly intricate.

Why nature has progressed food webs in bionetworks in the place of basic lined diet chains? This is since food webs give better steadiness to the ecology. In a lined food chain, if one breed goes extinct, then the breeds in the following tropic levels are also impacted. In a food web, on the other hand, there are multiple choices accessible at each tropic level. So, if one species is suffering, it does not impact other trophic levels so seriously.

Just consider the simple food chains of Arctic Tundra ecosystem:

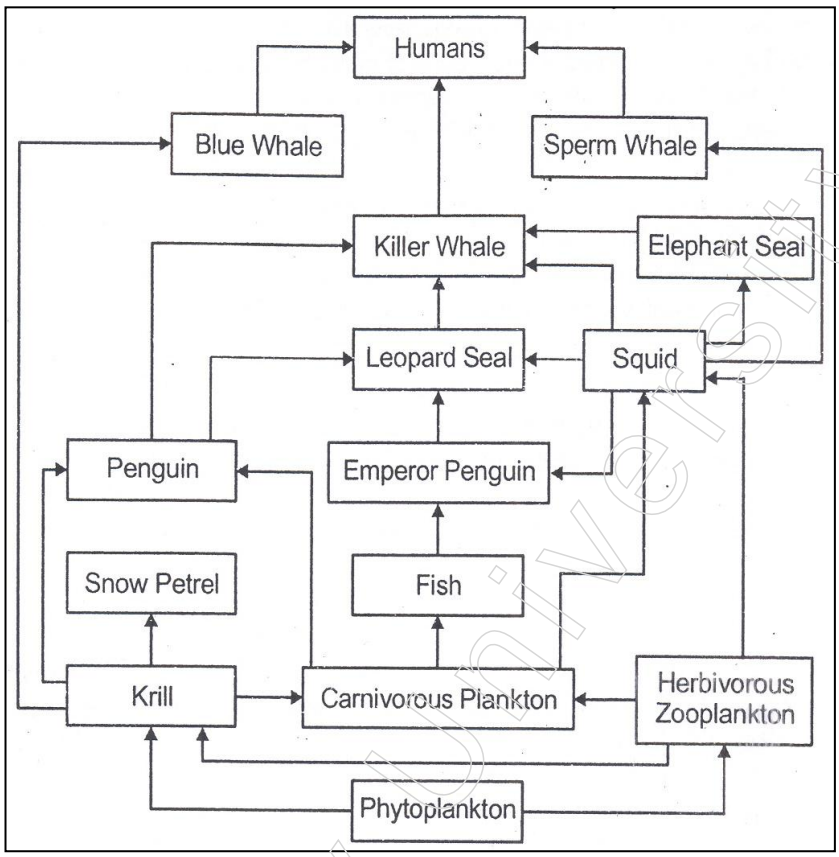

Fig. 3.5: A Simplified Food Web in Antarctic Ecosystem

Caledonia → Reindeer → Man

Grass → Caribou → Wolf

If due to some stress, the population of reindeer or Caribou falls, it will leave little option for man or wolf to eat from the ecosystem. Had there been more biodiversity, it would have led to complex food web giving the ecosystem more stability.

Significance of Food Chains and Food Webs

1. Food chains and food webs play a very important part in the ecology as they are the two most significant functions of ***energy flow and nutrient cycling take place through them.***
2. The food chains also aid in upholding and adapting to the inhabitants size of various faunas and so assist in maintaining the environmental equilibrium.

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3. Food chains show an exceptional property of **biological magnification** of some chemicals. There are numerous insecticides, hefty metallic element and other chemicals which are non-biodegradable in nature. These toxic substances are not decayed by microbes and they keep getting passed on from one tropic level to another. And at each successive tropic level, they keep on growing in concentration. This phenomenon is known as biomagnifications or biological magnification.

Case Study

A Build-up of DDT Concentration: A prominent case of Biomagnifications of DDT (a broad range insecticide) was detected when some birds like Osprey were seen suffering a high deterioration in their population, the off-springs of these birds were often hatched in untimely situations resulting in their demise. It was noticed later, which was due to biomagnification of DOT through the food chain. DOT sprayed for insect prevention was in very low concentration, but its absorption amplified along the food chain through phytoplanktons to zooplanktons and then to fishes which were eaten by the birds. The concentration of DOT was overstated several thousand times in the birds which triggered thinning shells in the birds' eggs, triggering deaths of their off-springs.

It turns out to be very evident from the above example that the fauna inhabiting the higher tropic levels are at a larger hazard of biomagnifications of lethal compounds. Humans eating and drinking milk, eggs and meat are at a higher tropic level. So, we have to stop undiscerning utilization of insecticides and hefty metallic element if we want to safeguard us from their purely overstated poisonous levels.

3.7 Ecological Pyramids

Picture demonstration of trophic construction and purpose of an ecology, beginning with creators at the bottom and successive tropic levels creating the top is recognized as a biological pyramid. Ecological pyramids are of three types:

1. Pyramid of Numbers: It denotes the number of distinct creatures at each tropic level. We may have *upright or inverted pyramid* of numbers, depending upon the type of bionetwork and food chain as shown in Fig. 3.6(a) grassland environment and a pond environment show a vertical pyramid of numbers. The creators in the plains are grasses and that in a pond are phytoplanktons (algae, etc.). They have a tiny size and are massive in number. So, the creators form an extensive bottom. The herbivores in grassland are insects while tertiary carnivores are hawks or other birds. They are progressively few in number. Hence, the pyramid top turns slowly thinner creating a standing pyramid. Similarly, with the herbivores, meat-eaters and topmost meat-eaters in pond which decline in quantity at higher trophic levels.

(c) Amity University Online

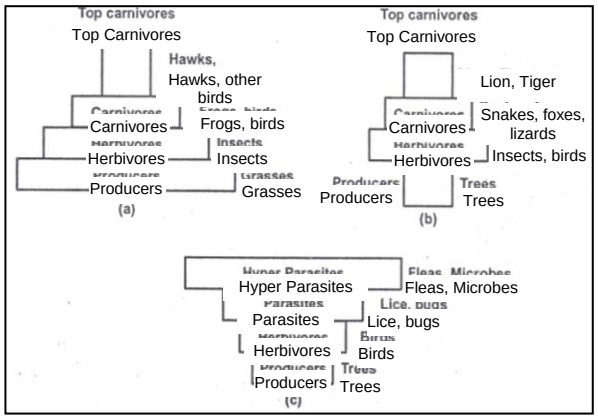

Fig. 3.6: Pyramid of Numbers: (a) Grassland, (b) Forest and (c) Parasitic Food Chain

In a woodland environment, large trees are the creators, which are fewer in amount and hence form a thin base. A greater number of herbivores including birds, insects and quite a few breeds of fauns eat up the plants (on leaves, fruits, flowers, bark, etc.) and create a wider mid-level. The subordinate eaters such as fox, snakes, lizards, etc. are less in quantity than herbivores while top carnivores like lion, tiger, etc. are still lesser in number. Thus, the pyramid is thin on each side and wider in the centre [Fig. 3.6(b)].

Parasitic food chain shows an upturned pyramid of number. The creators such as some large plants attract fruit eating birds acting like herbivores which are larger in number. A much bigger number of lice, bugs, etc. grow as parasites on these birds while a still larger number of hyper-parasites like bugs, fleas and microbes eat them, therefore creating an upturned pyramid [Fig. 3.6(c)].

2. Pyramid of Biomass: It is grounded upon the entire biomass (dry matter) at each trophic level in a food chain. The pyramid of biomass can also be *upright or inverted*. Fig. 3.7(a) show pyramids of biomass in a forest and an aquatic ecosystem. The pyramid of biomass in a forest is upright in contrast to its pyramid of numbers. This is since, the creators (trees) collect a huge biomass while the consumers' total biomass feeding on them drops at higher trophic levels, ensuing in extensive bottom and thinning topmost part.

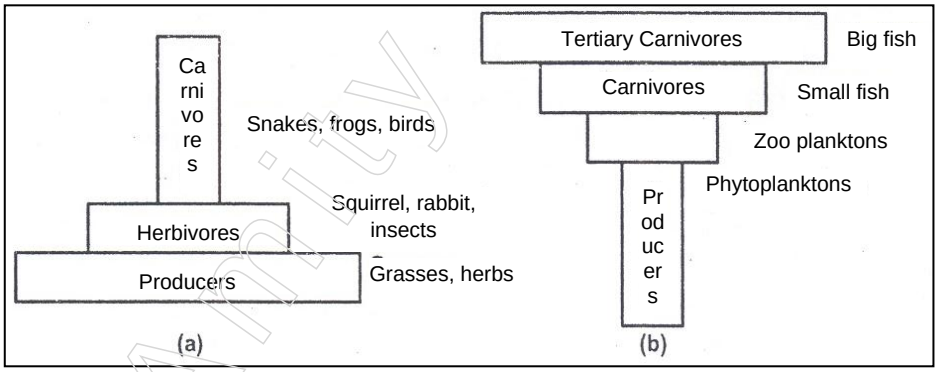

Fig. 3.7: Pyramid of Biomass: (a) Grassland and (b) Pond

The pond ecology displays a reversed pyramid of biomass [Fig. 3.7(b)]. The overall biomass of producers (phytoplanktons) is very little as compared to herbivores (zooplanktons, insects), carnivores (small fish) and tertiary carnivores (big fish). Therefore, the pyramid creates an upturned form with fine bottom and wide-ranging top.

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3. Pyramid of Energy: The quantity of radiation existing at each trophic level is considered for this type of pyramid. Pyramid of radiations shows the finest illustration of the trophic relations and it is permanently vertical.

At every succeeding trophic level, there is a massive losing of energy (about 90%) in the form of heat, respiration, etc. Thus, at each subsequent higher level, only 10% of the energy passes on. Hence, there is an immense deterioration in energy level of each consecutive trophic level as we change from creators to topmost meat-eaters. So, the pyramid of energy is permanently vertical as shown in Fig. 3.8.

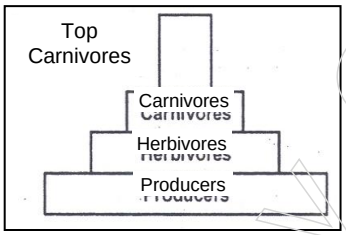

Fig. 3.8: Pyramid of Energy

3.8 Energy Flow in an Ecosystem through Food Chain

Flow of energy in an ecosystem takes place through the food chain and it is this energy flow which keeps the ecosystem working. The utmost significant element of this energy flow is that it is **unidirectional** or **one-way flow**. Unlike the nutrients (like carbon, nitrogen, phosphorus, etc.) which change in a recurring way and are recycled by the creators after flowing through the food chain, energy is not recycled in the food chain. Also, the flow of energy tracks the two laws of Thermodynamics:

1st Law of Thermodynamics states that energy can neither be created nor be destroyed, but it can be changed from single form to one more. The solar energy taken by the green plants (creators) gets transformed into biochemical energy of plants and later into that of consumers.

2nd Law of Thermodynamics states that energy dispels as it is used or in other words, it gets transformed from a more concentrated to dispersed form. As energy flows through the food chain, there occurs dissipation of energy at every trophic level. The loss of energy takes place through breathing, loss of energy in movement, running, hunting and other activities. At every level, there is about 90% loss of energy and the energy shifted from one tropic level to the other is only about 10%.

Energy Flow Models: The movement of energy through several trophic levels in a bionetwork can be described with the help of various energy flow models.

(a) **Universal Energy Flow Model:** Energy flow through an ecosystem was explained by E.P. Odom as the universal energy flow model (Fig. 3.9). As the movement of energy takes place, there is a steady loss of energy at all points, thereby resulting in reduced energy available at next tropic level as specified by thinner pipes (energy flow) and smaller boxes (stored energy in biomass). The loss is mainly due to energy not utilized (NU). The energy is lost in motion, excretion, etc. or it is lost in respiration (R) which is for maintenance. The remaining energy is utilized for production (P).

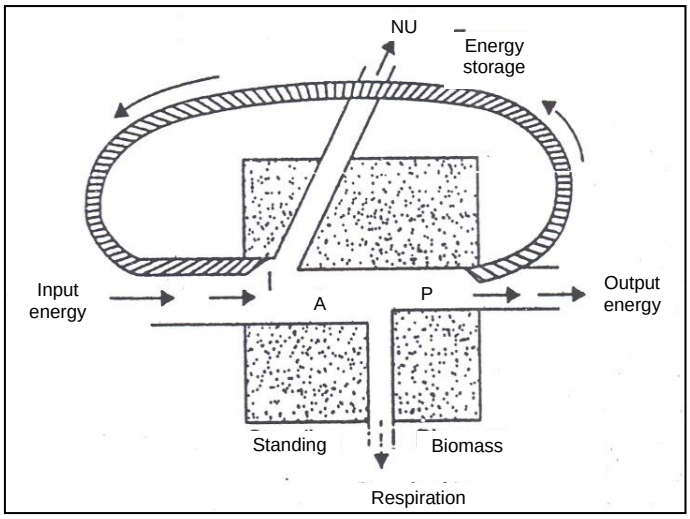

Fig. 3.9: Universal Energy Flow Model Applicable to All Living Components (I = Energy Input; A: Assimilated Energy; P = Production; NU = Energy Not Used)

(b) Single Channel Energy Flow Model: The flow of energy takes place in an unidirectional manner through a sole channel of green plants or producers to herbivores and carnivores. Fig. 3.9 represents such a model and illustrates the gradual decline in energy level due to loss of energy at each successive tropic level in a grazing food chain.

3.9 Primary Production and Secondary Production

Primary productivity of an ecosystem is defined as the rate at which radiant energy is converted to organic substances by photosynthesis or chemo-synthesis by the primary producers.

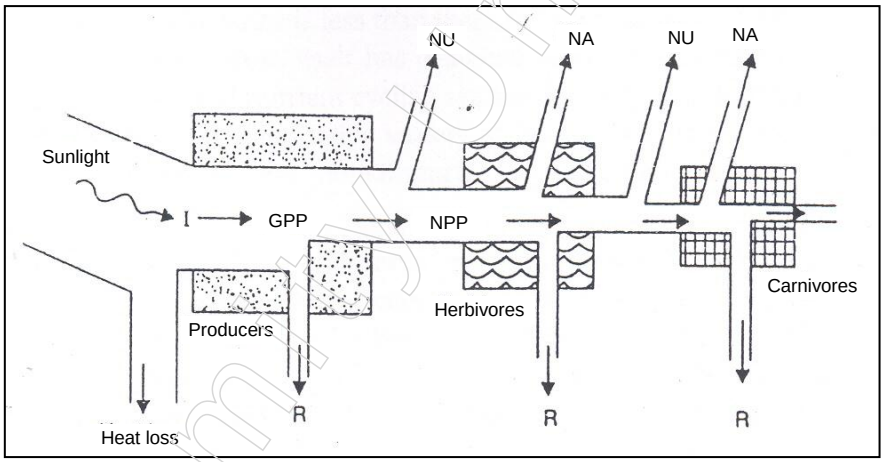

Fig. 3.10: One-way Energy Flow Model showing Unidirectional Flow through Primary Producers, Herbivores and Carnivores. At Each Successive Tropic Level, There is an Enormous Reduction of Energy (I = Solar Energy Input; GPP = Gross Primary Production; NPP = Net Primary Production; NU = Energy Not Used; NA = Energy Not Assimilated, e.g., Excretion; R = Respiratory Loss)

When biological substance is formed by the prime creators (mainly green plants and some bacteria), some of it is oxidized or burnt inside their body and gets

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transformed into carbon dioxide which is let out through breathing and is followed by decrease of energy. Breathing loss of energy is a must, because it is obligatory for the preservation of the creature. Now, the creators only have a small amount of biological substance than what was initially formed by them. This is known as the net **primary production (NPP)** and the respiratory loss (R) added to it gives the **gross primary production (GPP)**.

Thus, NPP = GPP - R.

Main creation of an environment is dependent upon the solar energy, obtainability of water and nutrients and upon the type of the plants and their chlorophyll content. Table 3.1 shows the average gross main output of some foremost ecologies.

Table 3.1: Main Output of Ecologies

Ecosystem	Gross Primary Productivity (K Cal/m2/yr)
Deserts and Tundra	200
Open Oceans	1,000
Grasslands	2,500
Moist Temperate Forests	8,000
Agro-ecosystems	12,000
Wet Tropical Forests	20,000
Estuaries	20,000

Output of tropical forests and estuaries are the maximum. This is because tropical forests have plentiful rainfall, warm temperature which is pleasant for growth, abundant sunlight and a rich diversity of species. Estuaries get natural energy subsidies in the form of wave currents that bring along with them nutrients essential for production.

Deserts, on the other hand, have restrictions of satisfactory water supply while Tundra has very low temperature as a limiting factor and hence shows low primary production.

Agro-ecosystems get lots of energy supports in the form of irrigation water, good quality seeds, fertilizers and insecticides and show a high productivity of 12,000 K Cal/ m^2/yr. Still, it is striking that their output is less than that of tropical forests which are not getting any artificial energy subsidies. Nature itself has designed its species arrangement, structure, energy capture and flow, and a closed nutrient cycling system that ensures a high primary production of 20,000 K Cal/m^2/yr. Also, the qualitative variety of the primary production is vast in the tropical forests. This makes it all the more imperative to save our tropical forests.

Secondary Production

The food synthesized by green plants through photosynthesis is the prime output which is eaten by herbivores. The plant energy is used up for producing organic matter of the herbivores which, in turn, is used up by the carnivores. The total of biological substance stockpiled by the herbivores or meat-eaters (in surplus of breathing loss) is recognized as subordinate creation. **The energy stored at consumer level for use by the next trophic level is thus defined as secondary production.**

3.10 Ecosystem Regulation

All bionetworks control themselves and uphold under a set of ecological guidelines. Any ecological pressure attempts to disrupt the usual ecology operation. Nevertheless, the environment, by itself, attempts to fight the alterations and preserve itself in

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symmetry with the atmosphere because of a feature recognized as **Homeostasis**. **Homeostasis is the integral property of all living systems to resist change.** Nevertheless, the building can display this acceptance or counterattack only within a maximum and a minimum range, which is its range of tolerance known as *homeostatic plateau.* Within this range, if any pressure attempts to reason in a variation, then the structure has its own devices to respond to these divergences which are identified as **negative feedback mechanisms**. **So, negative feedback mechanisms are deviation counteracting mechanisms which try to bring the system back to its ideal conditions.** But, if the pressure is extreme and crosses the range of homeostatic plateau, then one more kind of device identified as **positive feedback mechanisms** begins to function. These are the nonconformity accelerating mechanisms. **So, the positive feedback mechanisms add to the stress conditions and tend to take the system away from the optimal condition**s. Fig. 3.11 illustrates the environmental directive mechanisms.

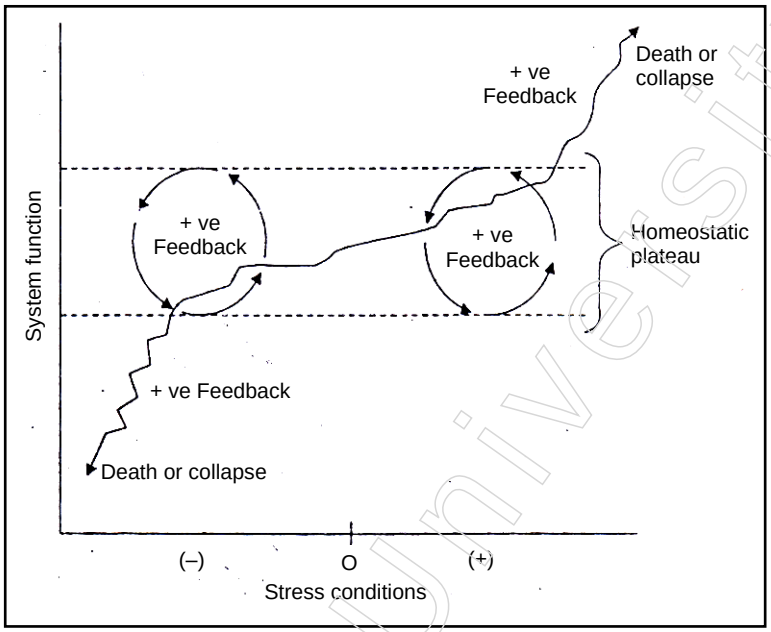

Fig. 3.11(a): Ecosystem Regulation by Homeostasis.

On application of a stress, the negative feedback mechanisms start operating, trying to counter the stress to regulate the system. But beyond the homeostatic plateau, positive feedback starts which further accelerate the stress effects causing death or collapse of the organism/system

Human beings should try to keep the ecologies within the homeostatic plateau. They should not contribute to positive feedbacks. Otherwise, the environment will breakdown.

3.11 Ecological Succession

Development of Community

Although a typical community maintains itself more or less in equilibrium with the prevailing conditions of the environment, in nature, this is hardly true. Communities are never stable, but dynamic, changing more or less regularly over time and space. They are never found permanently in complete balance with their component species or with

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the physical environment. Environment is always changing over a period of time due to: (i) variations in climatic and physiographic factors, and (ii) the activities of the species of the communities themselves. These influences bring about marked changes in the dominants of the existing community, which is thus sooner or later replaced by another community at the same place. This process continues and successive communities develop one after another over the same area, until the terminal final community again becomes more or less stable for a period of time. This occurrence of relatively definite sequence of communities over a period of time in the same area is known as **ecological succession**. Hult (1885), while studying communities of Southern Sweden, is said to have used for the first time the term succession for the orderly changes in communities. However, the authentic studies on succession were started in America by Cowles (1899, 1900). Clements (1907, 1916) thereafter put forth various principles that governed the process of succession, and while studying plant communities, defined succession as 'the natural process by which the same locality becomes successively colonized by different groups or communities of plants.

Odum (1971) preferred to designate this orderly process as ecosystem development rather than the more often one ecological succession. He made an elaborate statement to define this process, and in his own words, 'ecosystem development' or what is more often known as ecological succession, may be defined in terms of the following three parameters:

- It is an orderly process of community development that involves changes in species structure and community processes with time. It is reasonably directional and therefore predictable.
- It results from modification of the physical environment by the community, i.e., succession is community controlled even though the physical environment determines the pattern, the rate of change, and often sets limits as to how far development can go.
- It culminates in a stabilized ecosystem in which maximum biomass (or high information content) and symbiotic function between organisms are maintained per unit of 'available energy flow'.

Causes and Trends of Succession

Since succession is a process, more appropriately a series of complex processes, it is natural that there may not be a single cause for this. Generally, there are three types of causes:

1. **Initial or Initiating Causes:** These are climatic as well as biotic. The former includes factors such as erosion and deposits wind, fire, etc. caused by lightning or volcanic activity, and the latter includes the various activities or organisms. These causes produce the bare areas or destroy the existing populations in an area.
2. **Ecesis or Continuing Causes:** These are the processes as migration, ecesis, aggregation, competition, reaction, etc. which cause successive waves of populations as a result of changes, chiefly in the edaphic features of the area.
3. **Stabilizing Causes:** These cause the stabilization of the community. According to Clements, climate of the area is the chief cause of stabilization, other factors are of secondary value.

An ecological succession proceeds along the following four **trends:**

- A continuous change in the kinds of plants and animals.

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- A tending increase in the diversity of species.
- An increase in the organic matter and biomass supported by the available energy flow (but in heterotrophic succession reverse is true).
- Decrease in net community production or annual yield.

Basic Types of Succession

The various types of succession have been grouped in different ways on the basis of different aspects. Some basic types of succession are, however, as follows:

Primary Succession

In any of the basic environments (terrestrial, fresh water, marine), one type of succession is primary **succession** which starts from the primitive substratum, where there was no previously any sort of living matter. The first group of organisms establishing there are known as the **pioneers**, **primary community** or **primary colonizers**.

Secondary Succession

Another general type of succession is **secondary succession** which starts from previously built-up substrata with already existing living matter. The action of any external force as a sudden change in climatic factors, biotic intervention, fire, etc. causes the existing community to disappear. Thus, area becomes devoid of living matter but its substratum, instead of primitive, is built up. Such successions are comparatively more rapid.

Autogenic Succession

After the succession has begun, in most of the cases, it is the community itself which, as a result of its reactions with the environment, modifies its own environment and thus causing its own replacement by new communities. This course of succession is known as **autogenic succession.**

Allogenic Succession

In some cases, however, the replacement of the existing community is caused largely by any other external condition and not by the existing organisms. Such a course is referred to as **allogenic succession.**

On the basis of successive changes in nutritional and energy contents, successions are sometimes classified as:

Autotrophic Succession

It is characterized by early and continued dominance of autotrophic organisms like green plant. It begins in a predominantly inorganic environment and the energy flow is maintained indefinitely. There is gradual increase in the organic matter content supported by energy flow.

Heterotrophic Succession

It is characterized by early dominance of heterotrophs such as bacteria, actinomycetes, fungi and animals. It begins in a predominantly organic environment, and there is a progressive decline in the energy content.

In ecological literature, there are mentioned still so many other kinds of succession, depending mainly upon the nature of the environment (primarily based upon moisture relations), where the process has begun, and thus it may be a **Hydrosere or Hydrarch**–

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–starting in regions where water is in plenty, as ponds, lakes, streams, swamp, bog, etc., a **mesarch**—where adequate moisture conditions are present; and a **Xerosere or Xerach**—where moisture is present in minimal amounts such as dry deserts, rocks, etc. Sometimes, they are further distinguished, the **lithosere**—initiating on rocks, **psammosere** — on sand, and **halosere** — in saline water soil.

General Process of Succession

The whole process of primary auto trophic succession is actually completed through a number of sequential steps, which follow one another. These steps in sequence are as follows:

1. Nudation

This is the development of a bare area without any form of life. The area may develop due to several causes such as landslide, erosion, deposition, or other catastrophic agency. The causes of nudation may be:

Topographic

Due to soil erosion by gravity, water or wind, the existing community may disappear. Other causes may be deposition of sand, etc., landslide, volcanic activity and other factors.

Climatic

Glaciers, dry period, hails and storm, frost, fire, etc. may also destroy the community.

Biotic

Man is most important, responsible for destruction of forests, grasslands for industry, agriculture housing, etc. Other factors are disease epidemics due to fungi, viruses, etc. which destroy the whole population.

2. Invasion

This is the successful establishment of a species in a bare area. The species actually reaches this new site from any other area. This whole process is completed in following three successive stages:

Migration (Dispersal)

The seeds, spores, or other propagules of the species reach the bare area. This process, know as **migration**, is generally brought about by air, water, etc.

Ecesis (Establishment)

After reaching to new area, the process of successful establishment of the species, as a result of adjustment with the conditions prevailing there is known as **ecesis** in plants, after migration, seeds or propagules germinate, seedlings grow and adults start to reproduce. Only a few of them are capable of doing this under primitive harsh conditions, and thus most of them disappear. Thus, as a result of ecesis, the individuals of species become established in the area.

Aggregation

After ecesis, as a result of reproduction, the individuals of the species increase in number and they come close to each other. This process is known as **aggregation.**

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3. Competition and Coaction

After aggregation of a large number of individuals of the species at the limited place, there develops **competition** (inter- as well as intra-specific) mainly for space and nutrition. Individuals of a species affect each other's life in various ways and this is called **coaction.** The species, if unable to compete with other species, if present, would be discarded. To withstand competition, reproductive capacity, wide ecological amplitude, etc. are of much help to the species.

4. Reaction

This is most important stage in succession. The mechanism of the modification of the environment through the influence of living organisms on it is known as **reaction.** As a result of reactions, changes take place in soil, water, light conditions temperature, etc. of the environment. Due to all these, the environment is modified, becoming unsuitable for the existing community which sooner or later is replaced by another community (seral community).

5. Stabilisation

The sequence finally concludes in fairly steady group termed as **climax** which is in balance with the atmosphere.

The climax group is characterized by extreme biomass and synergetic (equally useful) connections amongst creatures, and are sustained rather proficiently on units of obtainable energy.

Let us contemplate in brief two classes of sequence:

(a) Hydrosere (Hydrarch): This kind of sequence begins in an aquatic body like pond. Several transitional phases originate and eventually it terminates in a climax group which is a woodland.

The creator group involves of phytoplanktons, which are unrestricted moving algae, diatoms, etc. Progressively, these are substituted by deep-rooted underwater floras trailed by deep-rooted moving floras. Development of such floras add to the biological substance to the rock layer by decease and degeneration, and accordingly, a coat of mud shapes up and shallowing of water occurs. Then, Reed swamp (swampy) phase trails, where the floras are partially in water and partially on land. This is trailed by a sedge field stage of lawns then by a forest comprising of bushes and plants and lastly by a woodland as a climax [Fig. 3.12(a)].

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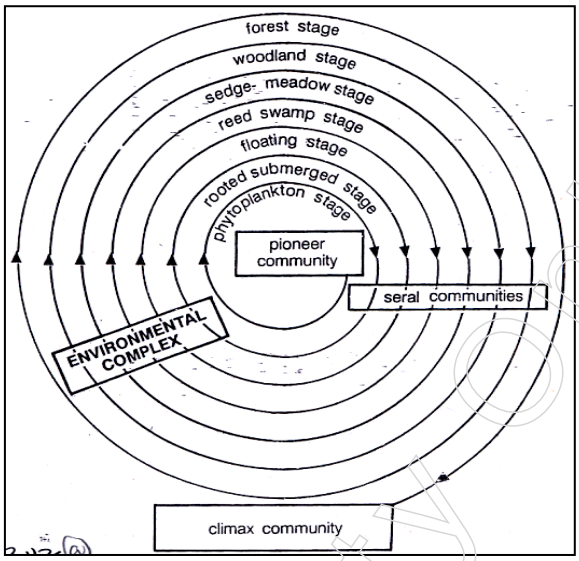

Fig. 3.12(a): Diagram to Show General Process of Succession with Different Plant Communities Appearing therein under the Influence of Developing Environmental Complex

Taking Hydrosere as an example, note the Pioneer, Seral and Climax Communities. Eventually, the former lake is covered by climax woodland community, representing a terrestrial ecosystem.

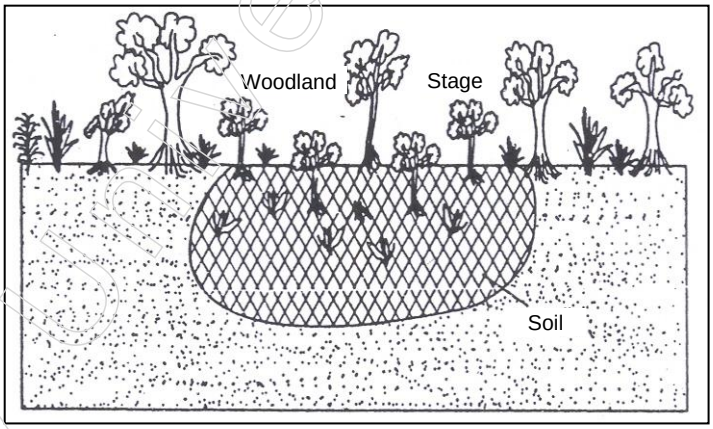

Fig. 3.12(b): Ecological Succession: A Hydrarch - From Lake to Woodland Community

(b) Xerosere (Xerarch): This kind of sequence initiates on a plain rock, which has absence of water and biological substance. Fascinatingly, the climax group is a woodland, though the middle phases are dissimilar.

The developer group comprises of foliaceous lichens. These lichens make few frail acids and aid in decomposing the pebble, a procedure identified as *weathering.* Their development benefits in structuring progressively few biological substance, humus and soil. Then arises the group of mosses, trailed by herbs, shrubs and lastly the woodland plants. Through this steady procedure, there is a gradual buildup of biological substance and water in the bedrock.

Thus, sequence inclines to change in the direction of mesonic circumstances (reasonable situation), regardless of the statistic, whether it began from a

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dehydrated (xeric) situation or a humid (hydric) situation, and it concludes in a constant climax group, i.e., typically a woodland.

3.12 Major Components of Ecosystems

Abiotic Components

Abiotic components or non-living components are air, water, soil and several other essentials and mixtures of the atmosphere. Such inorganic materials arrive in the body of living organisms and take part in the metabolic activities, and lastly, go back to the atmosphere. The inorganic components are further subdivided into three parts:

(a) **Bodily issues** like heat, stickiness, etc. They are also called climatic factors.

(b) **Inorganic substances** like water, nitrogen, carbon, sulphur, etc. They take part in the driving of resources into the ecology.

(c) **Organic substances** proteins, carbohydrates, etc. They make the structure and relate organic and inorganic elements of the atmosphere.

All these components are found in each environment, but dominance of a few components varies from one ecosystem to another. On land, the climate and soil are the leading aspects; at high altitudes, oxygen becomes the most vital component; and in aquatic ecosystem, sunlight and salinity become the controlling factor.

The number of inorganic components existing in an environment at a particular period is termed as the standup phase or standup feature of ecology.

Biotic Components

On the trophic or nutritional basis, there are three biotic components: autotrophic, heterotrophic and decomposers.

(a) **Autotrophic Components:** Those components include green plants, algae, bacteria, grasses, mosses and entire photosynthetic creatures. They are also called producers because they change sun's radiations into biochemical radiations with the support of inert elements like water, carbon dioxide and organic substances like enzymes. They are called autotrophic because *'auto'* means *'self'* and *'trophic'* means *'nourishing'.* They possess green pigment called chlorophyll which transfers energy from sunlight.

(b) **Heterotrophic Components:** These components are unable to produce their own food and are called consumers. They consume the matter formed by the main components or autotrophs. They are called heterotrophic because *'hetero'* means *'others'* and *'trophic'* means *'nourishing'.* They may be microorganisms like zooplankton, insects and animals like cow, deer, tiger, elephant, etc. Some animals eat plants and are called herbivores or primary consumers, and some are flesh eating animals and are called carnivores or secondary consumers. Collectively, they are called Macro-consumers.

(c) **Decomposers:** Decomposers are also heterotrophic organisms but depend upon the dead animals for their food. They are the microorganisms like bacteria, fungi, etc. Several worms are also included in this category. They disintegrate the multifaceted organic matter like cellulose and chitin which are obtained in plant and animal bodies. After breaking down, they convert the matter into simple substances which are easily usable by the plants. They are also called reducers or Micro-consumers. *Bacterium is a single-celled microorganism without distinct nuclei and organized cell structure.*

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Table 3.2: Comparative Learning of Organic and Inorganic Elements in Grassland and Pond

Grassland	Pond
1. Abiotic matter: In grassland, the abiotic material is soil, nutrients of soil are organic matter like proteins, carbohydrate s, lipids, etc. The climatic factors are temperature, rainfall, light, etc.	Abiotic matter in a pond is water, nutrients in water, organic matter like proteins, carbohydrates, lipids, etc. The climatic factors are sunlight, wind, currents, etc.
2. Producers: Herbaceous plants are predominant producers in grassland. They change sun's radiations into biochemical radiations with the aid of chlorophyll, carbon dioxide, water, macro and micronutrients. This biological procedure is recognized as photosynthesis.	In a pond, the producers are microscopic organisms like phytoplankton floating in water. They utilize carbon dioxide and bicarbonates present in water. Their bodies also have chlorophyll and therefore, are able to change sun's radiations into biochemical radiations.
3. Consumers: Cattle, sheep, goat, insects are the main consumers which feed on grass. Major carnivores are snakes, hyenas, birds, etc.	Major carnivores are zooplankton, which feed on phytoplankton. Some fish also feed on the phytoplankton. Carnivores are large fish and other invertebrate animals.
4. Decomposers: Bacteria, fungi, protozoa and several other invertebrates are the chief decomposers of grassland. They decay the deceased substance of floras and faunas and emit the minerals into the soil which again are available to the producers of plants.	Bacteria, fungi and several other invertebrate animals are main decomposers in the pond. They are present in water and sediments. They decay the deceased substance and release the minerals into water which again are available to the producers or phytoplankton.

In Ecosystem functioning (Pg. 74). The first was Energy Flow, the second is called productivity and the third will Biogeochemical cycling or Nutrient Cycling.

2. Productivity:

The productivity of an ecosystem means the rate of production or the quantity of biological material accumulated in a unit of time. The productivity can be of three types:

(a) Primary Productivity

(b) Secondary Productivity

(c) Net Productivity

(a) Primary Productivity: It is the amount at which the solar energy is stored by photosynthesis process. Therefore, it is stored in the green plants and planktons.

(b) Secondary Productivity: It is the proportion of energy deposited at consumer level. This energy is always mobile from one organism to another.

(c) Net Productivity: It denotes the amount of storage of organic matter that is not used by consumers. Therefore, it is the rate of increase of biomass of the primary producers that has been left by the consumers.

3. Biogeochemical Cycling or Nutrient Cycling

The biochemical compounds mingle in the environment in cyclic paths, i.e., from atmosphere to creatures and from creatures back to atmosphere. The driving of foods starts when they are released from biological substance by withstanding or decay. Then they are consumed by floras and are stocked in their cells. The nutrients are then moved

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from one trophic level to another. The movement is in circular path. Therefore, it is called biogeochemical cycles. There are around 40 elements or nutrients that are mandatory for the growth, but hydrogen, carbon and oxygen are the basic elements. Other important elements are phosphorus, nitrogen, calcium, potassium, sulphur, iron, manganese, etc. All the elements circulate at the ecosystem level as well as at the global level cycle. The important cycles are:

(a) Hydrological Cycle: Also known as water cycle, it is the most important cycle in ecosystem. In this cycle, water interchanges between surface of earth and the atmosphere. It involves two processes of evaporation and rainfall. Water from various water bodies is evaporated to atmosphere with the benefit of solar energy. In the atmosphere, the temperature falls and the water is condensed to form clouds which result in rainfall. The water thus again reaches to the ground. Part of rain water is soaked by the soil which becomes underground water. Some part of water is soaked by the plants and animals which is again released through evapotranspiration and respiration. Thus, there is continuous cycling of water.

(b) Carbon Cycle: It is also an important cycle specially for man. Little amount of carbon dioxide is available in the atmosphere, i.e., 0.03%. It is the solitary foundation of carbon that passes through various organisms in all the food chains. First of all, the carbon moves from air to the green plants, then to the animals, and at last decomposers return it to the atmosphere through decomposition of dead matter. Part of carbon cycle also operates in the sea.

(c) Nitrogen Cycle: Nitrogen is in abundance in the atmosphere, i.e., 79%, but it is never taken directly from the atmosphere. Soil is the major source of nitrogen for plants. The soil contains the nitrates. The reduced and oxidized forms are involved in this cycle. Nitrogen fixation in soil is done by bacteria belonging to genus Rhizobium which is created in the roots of leguminous plants. Blue-green algae are also nitrogen fixers. Plants are eaten by animals, and then bacteria and fungi decompose the deceased substance of plants and animals. The decomposers release nitrogen directly to the air or release as ammonia gas which reaches the soil as nitrates.

(d) Oxygen Cycle: It is the second major gas (21%) present in the atmosphere after nitrogen. It is available in bound state as oxides and carbonates in rocks and water. During the procedure of photosynthesis, the plants release oxygen which is used in respiration by all organisms. It is also used in oxidation of organic matter. Another role of oxygen is in the stratosphere where it absorbs the ultraviolet rays in the form of ozone.

(e) Phosphorus Cycle: It is a simple sedimentary cycle. Phosphorus is an important constituent of protoplasm. Phosphorus circulates organic compounds by breaking them down as phosphates which are again available to the plants. Phosphorus is found in abundance in the rocks. Large part of phosphates goes to the sea in the form of sedimentation. Sea birds bring this phosphorus back to land.

3.13 Balance in Nature

All ecosystems play very important role in the balance of nature. All organisms are interdependent upon each other and also on their environment. All the organisms have to interrelate with one another and with the environment, so that the balance in nature is maintained. The balance between all living beings and amongst organic and inorganic

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living and non-living things is called the ecological balance. This balance is attained with the support of nature.

Man has intervened in most of the ecosystems on earth. The main reason for his intervention is the overgrowing population. The demands of population, therefore, are increasing day by day. Many habitats have been totally removed. As a result, the organisms of such habitats have either become extinct or shifted to other ecosystems. It led to large-scale changes in various ecosystems. Even the inorganic elements of ecosystems have also been altered. If the ongoing interference in the ecosystems is not checked, the result could be harmful for men as well as for other organisms of ecosystems. Role of man has to be curtailed so that the balance in nature is maintained.

Points to Remember

1. Abiotic components include temperature, water, carbon, etc.
2. Biotic components are autotrophic, heterotrophic and decomposers.
3. Autotrophic components or producers change sun's radiations into biochemical radiations.
4. Heterotrophic components or consumers consume the matter produced by autotrophs.
5. Decomposers or microorganisms depend upon the dead animals for their food.
6. Energy is transferred at all the trophic levels.
7. Food chain makes the relationship between organisms and food web links the food chains.
8. Productivity of an ecosystem is the quantity of biological substance accumulated in a unit of time.
9. The chemical elements mingle in the environment in cyclic paths.
10. The balance amongst all living beings and amid organic and inorganic compounds is called the ecological balance.

3.14 Terrestrial Ecosystems: Forests, Grassland and Deserts

1. Forests

Forest is a plant community predominantly of trees and other woody vegetation occupying a large area. In the natural state, a forest remains generally fixed in a self-administered situation over an extended time period. The determining factors of a forest are climate, soil and topography. Because vegetation also affects the soil, therefore, the relationship is reciprocal between physical environment and the life-forms. Deforestation and natural forest fires are the major disturbances in the forests. Major forest types are:

(a) Tropical Rainforests: These woodlands originate in the equatorial areas of high temperature and heavy rainfall. Here, average annual temperature remains above 17°C and average rainfall remains above 240 cm a year. Such conditions favor the growth of thick and dense evergreen forests. Soils of this area are of poor quality yet other conditions favor luxuriant growth of forests. All the nutrients of the soil are leached down due to heavy rainfall. The layer of humus, therefore, remains absent. High temperature and moisture quickly decompose the fallen leaves and return them as nutrients to the vegetation. When these forests are cleared, the soil cannot support good agricultural practices for an extended time.

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Rainforests are the most diverse ecosystem on the earth surface. Although they over only 7% of the earth surface, yet they contain more than 50% of the herbal and fauna breeds. One hectare of tropical rainforests supports more than 600 species of trees. Major trees growing in these forests are kapok, mahogany, rosewood, etc.

Ceiba *tree may reach height of 40 metres with bell-shaped flowers. It is cultivated for its fibre. Palm is a woody flowering plant of tropics and is grown for its food, fibre and oil.*

More than 90% of the animals of these forests are insects and most of them are beetles. Leafcutter ants, okapis, galagos, tapirs, elephants, gorillas, agoutis, wild pigs and monkeys are some of the prominent animals of these forests.

Epiphyte Orchids *are plants* that do not require soil to grow. They grow on tree trunks and branches like many other epiphytic plants.

Tropical rainforests are originated in Northern South America, Central America, Central Africa, Southeast Asia and several islands of Indian and Pacific Ocean. Rainforests of Amazon River basin in Brazil are the largest forests in the world. They cover more than 3.5 million sq. km. surrounding about half of the total rainforests of the world. The second largest area of these forests is the Congo River basin of Africa along the Atlantic Coast.

(b) Temperate and Sub-tropical Evergreen Forests: These woodlands are also identified as temperate rainforests. They grow in the areas of heavy rainfall of middle latitudes. In the temperate areas, western parts of the continents receive heavy rainfall from westerly winds. In sub-tropical areas, the eastern parts of the continents receive heavy rainfall through trade winds. Heavy rainfall makes them evergreen throughout the year. Sunlight can easily penetrate the canopy of these trees. Therefore, ground vegetation is well developed in the form of epiphytes. They are widespread in the western parts of North America and eastern parts of Asia. In the southern hemisphere, they grow in Chile and New Zealand. Both conifers and broad-leaved trees make up these forests, but conifers are very large in size. Red wood, hemlock, oak, magnolia and spruce are the important trees.

Spruce *has 40 species among which Black, White and Red Spruce are important species. Black Spruce and White Spruce dominate Canada. Red Spruce is a valuable timber tree and is found in the eastern USA.*

Animals that inhabit these forests are puma, jaguar, bear, etc. Kiwi is typical of New Zealand only. Besides kiwi, many other flightless birds inhabit the New Zealand because of almost absence of predators. After the colonization of these islands, many species have become extinct and many are endangered.

(c) Boreal Evergreen Forests: These trees grow in the cold areas of northern hemisphere. The winter season is long and the growing period is short. During winters, the water remains frozen and therefore, is unavailable for tree growth. Shape of the leaves in these trees is needle-like which retard the loss of moisture during winter season. The trees therefore, remain evergreen. They are cone-shaped. Therefore, snow slips down easily. Ground vegetation is very little which is limited to sparse shrubs and mosses. Pine, fir and birch are common trees of taiga forests. They are widespread in Russia where they are called taiga. They are also found in northern parts of Europe and North America.

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Pine *tree has more than 210 species. Bristlecone pine can live for more than 5000 years.*

Larch *is an important timber tree and is planted in Europe as a crop.*

Cedar *is an ornamental tree. Best known cedar tree is in Lebanon which has reference in 'Old Testament'.*

During summers, large number of birds migrate here which feed on the insects. Lemmings, fox, wolves and reindeer are other prominent animals of these forests.

(d) Temperate Deciduous Forests: They shed leaves during the drought season, i.e., winter season in most of the cases. Trees, woody vines and shrubs are common vegetation of these forests. As the spring approaches, the forest floor is carpeted with the flowers. Temperate deciduous forests are mostly confined to the northern hemisphere especially Central North America, most parts of Europe and Eastern Asia.

Important breeds of plants are elm, walnut, maple, birch, beech, alder, chestnut, ashes, etc. Popular animals inhabiting these forests are antelope, boars, turkey hens, stone partridges, black grouse, hyenas, squirrels, etc. The endangered animals are Chinese egrets, red-crowned cranes and Nordmann's greenshanks.

Bark of Birch was used by native Americans to build boats.

(e) Mediterranean Forests: They are originated in those areas which receive most of the rainfall during winter season, and in summers, they remain dry. They grow in areas of mild temperature and are also identified as chaparral. Trees remain short in height, and their leaves are thick and leathery that can retain moisture for a long time. Shrubs are very common in these forests. Fire is a regular feature of these forests, but many trees are fire-resistant. Mediterranean trees are found in five regions only. The most important and widespread region is the area around Mediterranean Sea including Southern Europe and Northern Africa. Other four regions are on the western sides of the continents, i.e., western coast of North America in USA, western coast of South Africa in Chile, western coast of Australia and western coast of South Africa. Main trees of these forests are matorral, scrub oak, cork oak, etc. Citrus fruit trees are common around the Mediterranean Sea. Among them, orange, lemon and grapes are popular.

Sonoma Valley of California leads in the production of grapes which has spurred the wine industry.

Wolf, wild boar, antelope, fox and weasel are the common animals of this region.

Popular birds are stork, partridge, nightingale and turtledove.

(f) Tropical Deciduous Forests: They are also known as tropical monsoon forests. Climate of this area is not very wet. The rainy season alternates with the dry season. Trees, therefore, shed their leaves during dry season and trees appear as lifeless. But during rainy season, they appear lush and green. Trees are not dense and they grow at distance from each other. Growth of trees is however dense along the rivers. In the areas of little rainfall, the grass absorbs the pouring rain drops quickly and do not allow it to leach down in the soil where trees can absorb it. Therefore, trees are scanty in such areas. Where rainfall is sufficient but drainage is poor, water logging takes place. Here, again, grass grows more than the trees. Where rainfall is sufficient and slope makes good drainage of water, there soil can absorb moisture for an

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extended time which is suitable for the trees. Bamboo, teak and thorny trees grow in these areas. This type of vegetation is common in the Southeast Asia, Northern Australia, Southern Brazil and Central America.

Bamboo is extensively used by humans for houses, bridges, rafts, scaffolding, etc. It has 480 species and grows widely in southeast Asia. Its height varies from 1 to 150 metres.

Important animals of this area are buffalo, fox, wild dog, deer, bear, etc. Among reptiles, cobra and python are common.

2. Grasslands

In the grasslands the grass, sedge and forage plants are the dominant vegetation. Grasslands are natural, semi-natural or cultivated. The grasslands occupy large continental areas. The important grasslands are Prairies of North America, Pampas of South America, Veld of South Africa, Steppes of Eurasia and Downs of Australia. Sedge is a grass-like plant with triangular stems characteristic of low to moderate rainfall. Deficiency of rainfall restricts the growth of trees. Temperate grasslands grow in the areas characterized by 25-75 cm of average annual rainfall, high rate of evaporation and seasonal droughts. Conditions in the tropical grasslands are marked with wet and dry conditions. On the periphery of tropical grasslands, fire is a routine phenomenon. The fire prevents the infringement of forests in wet areas find desert shrubs in the dry areas.

Semi-natural grasslands are also called successional grasslands. They are found in the areas where the moisture is adequate for provision of the growth of trees: They are the result of deforestation activities like burning, cutting, grazing, mowing, etc. and may return to forests in the absence of deforestation activities.

Some grasslands are cultivated like hayfields and pastures. They are artificially planted and maintained. They frequently contain one or two species of grasses accompanied with legume plant like clover or alfalfa. Soils of all grasslands are very fertile. Little rainfall cannot wash away the soil nutrients. Humus content is high. Therefore, many grasslands have been converted into farming lands.

Grasslands support large number of grazing herbivores like bisons, zebras, tigers, gazelles, giraffes, leopards, deers, hawks, snakes, etc.

3. Deserts

Desert is a large area with high evaporation and low precipitation. Normally, the average annual rainfall is less than 25 cm. Most of the deserts are situated on the Tropic of Cancer and Tropic of Capricorn. A few deserts are situated in the temperate areas also. Temperatures remains high in the tropical deserts and severe winters are peculiar of temperate deserts. Daily range of temperature is high because day temperature touches 50°C, and at night, the floor of desert radiates back all heat to the atmosphere and temperature sometimes nears freezing point, 30% of the land surface is covered with the deserts. ***Taklimakan*** *is a desert in northwest China covering an area of 360,000 sq. km. Earlier, it was a fertile region and an important centre of Buddhist civilization. But today, it is an uninhabited area of drifting sand dunes.*

Most of the deserts are caused by the movement of air masses. Hot air after rising from equator flows northwards and southwards, and then it descends as two high pressure belts of sub-tropical areas. The rising air brings rainfall, but descending air dries out the land. Other factors of desert formation are ocean currents and mountains causing rain shadow areas. The deserts are, therefore, caused at the subtropical areas where air descends. Important deserts of northern hemisphere are Sahara Desert of Africa, Gobi Desert of China, California Desert of North America, Arabian and Iranian

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Desert of the Middle East. The deserts of southern hemisphere are Patagonia Desert of Argentina, Atacama Desert of Chile, Kalahari Desert of South Africa, Namib Desert of South-west Africa and Great Victoria and Great Sandy Desert of Australia. Plant life of deserts is well adapted to dry conditions and daytime heat. Desert plants consume water efficiently. Some of the plants are ephemeral that live just for a few days. The seed lying in the soil may remain dormant for many days and sometimes for year and until rain comes to germinate it. Woody plants with deep roots are able to absorb water from depth. Plants with shallow and spreading roots are able to absorb whatever little water is available in the form of dew or occasional rain. Plants normally have small leaves because it reduces the surface area for minimum transpiration. Some plants drop their leaves during dry season. The process of photosynthesis is normally carried on by the leaves, but in deserts, this process is taken over by the stems. Most of the plants of deserts are succulents that absorb water in root, stem or leaves. Thorns are a type of leaves which guard the plants against grazing animals. Desert plants are adapted to close their stomata or aquatic ecosystems occupy more than 70% of the earth surface. They include rivers, lakes, wetlands and oceans. These ecosystems play a dominant role in the cycling of chemical substances and are capable of affecting the terrestrial ecosystems. Aquatic ecosystems differ from terrestrial ecosystems. Terrestrial ecosystems are mainly controlled by the temperature and rainfall. The aquatic ecosystems are hardly affected by the rainfall and water tends to moderate the temperature of its own. In aquatic ecosystems, the determining factors are penetration of sunlight in water, salinity, waves, currents and nutrient levels.

3.15 Aquatic Ecosystem: Fresh Water, Coastal Water and Marine Water

The aquatic ecosystems can be divided into three categories:

1. Fresh Water Ecosystem
2. Coastal Water Ecosystem
3. Marine Water Ecosystem

1. Fresh Water Ecosystem

A variety of plant and animal life flourishes in the fresh water bodies. Fresh water includes the flowing waters of streams and rivers and still waters of lakes and ponds. The fresh water ecosystem can be more segmented into two parts:

(a) Lotic ecosystem

(b) Lentic ecosystem.

(a) Lotic Ecosystem: The flowing water of rivers makes the lotic ecosystem. It comprises of headwater zone or upper valley from where a river originates, middle valley of plains and lower valley or mouth of river where it falls into the sea.

(i) Headwater: Organisms in the headwater or upper valley are adapted to maintain their position in the fast-flowing cold water. Animals of this zone either have streamlined bodies for minimum drag or have small hooks and suckers that enable them to cling to the rocks. Fish like brook trout and insect like mayfly nymph have streamlined bodies thus reducing resistance to current. Mayfly spends one to three years as underwater nymph and breathes through its gills. The stonefly nymph has flattened body. So, it can hide underwater and cling to the underlying rocks. Blackfly larvae attach themselves to rocks with hooks and suckers.

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Caddisfly larvae build small cases of pebbles with which they remain hooked. Among plants, the water moss remains dinged to rock and aligns with the current. Algae is also common that grows tightly to the rocks.

Mayflies are the oldest insects and their fossils date back to 300 million years. They are the only insects that molt in winged stage. Molt means periodic shedding of skin or feathers.

(ii) Middle Valley: As the river enters the plains, its speed reduces due to gentle slope. Under this condition, the river widens its valley. Water on the margins or along the banks is slower than the middle water of the river. Only this nominal change in the environment is sufficient to change the species of organisms in water. Bass, sunfish and other free-swimming organisms are adapted to slow-moving water and warm temperature. Therefore, they remain along the banks. Bass is also known as largemouth. The sunfish rarely exceeds 25 cm in length.

Important plant life includes the phytoplankton that is microscopic in size and flows with the current. Some rooted plants also grow in shallow water. Their types depend on the surrounding land environment.

(iii) River Mouth: The area where river joins the sea is almost flat. Therefore, water of river gets distributed into channels which is called delta. When water joins the sea in one channel only, it is called **estuary.** Both delta and estuary is suitable place for the growth of organisms. Plant and animal life in this part of river vary greatly. Tropical areas have abundant variety as compared to temperate areas.

Fishes, crabs and shrimps are common animals found in this zone. Other animals are ducks, geese and herons. Very often, marine animals move into this zone and fresh water animals move out into seas. Among microscopic animals, 'phytoplankton' is in abundance that is consumed by 'zooplankton' and zooplankton is eaten by fishes and other animals. High productivity is the main feature of this zone. People living around this area catch a huge number of fish. [***Sundarbans***, *situated in India and Bangladesh, is the largest delta in the world formed by rivers Ganges and* ***Brahmaputra***.]

In plants, the variety ranges from microscopic phytoplankton to rainforests. Phytoplankton is single-celled algae and a group of algae is called diatom. Grasses and rooted plants are common in the marshy areas. Mangrove trees are most common throughout the world. Sundarbans of India is typical example of mangrove trees. Tidal rainforests are the richest estuarine ecosystem on the surface of earth. The huge tidal rainforests are the most abundant in Amazon river basin. *Plankton is a mass of tiny or microorganisms that float in the water. Their movement depends on currents and waves. Phytoplankton is made of bacteria, algae and fungi. Zooplankton is made of protozoa, mollusks, worms, etc. Zooplankton feeds on phytoplankton. Both are food for other sea animals.*

(b) Lentic Ecosystem: Lentic ecosystem is made by still water in the form of fresh water lakes and ponds. Still water is normally warmer than the rivers and streams of the same area. As a result, this ecosystem is proficient of supporting many kinds of plant and animal life.

Notes

Green-colored blanket is common to see on still waters like 'duckweed' which are common aquatic plants. Duckweed is a major source of food for many aquatic animals. They are floating plants on water. They block the sunshine for lower parts thus reducing oxygen in water. Organisms that flourish below the duckweed layer are desmids (algae), protozoan (microorganisms) and animals like crab, shrimp, snail, lobster, etc.

Shallow water areas support a variety of free-swimming animals like fish and frogs. Deep areas have comparatively lesser oxygen. Therefore, only those animals are found here that are adaptable to cold conditions such as mayfly, midge larvae, protozoans, etc.

Plankton and algae are most common of lentic ecosystem. They supply the maximum energy in the lentic ecosystem. Among planktons, both plant plankton and animal plankton are found.

Marshes: Marshes are the flooded areas that are characterized by non-woody plants. The area may be periodically or continually flooded. These plants are altered to saturated soils and shallow water. Soil of marshy areas is often rich in minerals. Some of the major marshes of the world are Everglades of South Florida, Prairie potholes in central North America and coastal areas of Great Lakes at several places in North America. Rann of Kutch is a large marshy area situated in India and Pakistan. It is a famous breeding ground for flamingos, pelicans, cranes and storks.

Peat is partially decayed vegetation material found in wetlands. In Europe, farmers cut the dry blocks of peat to use as fuel.

Swamps: Swamps also occur in flooded areas, but they are dominated by trees and shrubs. The soil varies in mineral and nutrients. Standing water may be present whole of the year or just a part of the year. Swamps are common in the quite waters of lakes. Some marshes are also found in the river flood plains. Some of the common swamps are hardwood forests of lower Mississippi river and Okefenokee swamp in North America. Several swamps are found in the tropical Africa, tropical South America and Southeast Asia. In India, Konalar near Kodaikanal is a large swamp, another famous swamp is Keoladeo Ghana National Park of Rajasthan. During monsoon, 29 sq. km of its area gets flooded that provides habitat to large number of waterfowl.

2. Coastal Water Ecosystem

It is also referred as inter-tidal zone which is placed between terrestrial ecosystem on land and neritic ecosystem in ocean. It is the shallow zone where land meets water. This zone is alternately submerged and exposed due to daily occurrence of tides. The organisms of this zone are, therefore, subjected to great deal of variation. Waves add to the battering of these organisms. In the temperate areas, these organisms are subjected to freezing temperatures in winter season and very high temperatures during summer season. During low tides, they are subjected to predation by animals like birds and mammals. During high tides, fish are their predators. Common coastal or littoral organisms are green algae, fungus, lichens, snails, crabs, sea anemones, small fish, etc. This ecosystem is generally further subdivided into three zones:

Upper littoral zone rarely submerges during highest tides and otherwise remains exposed during normal high tides.

Mid littoral zone submerges on all high tides and is exposed to low tides. This zone has greatest variety of organisms. There is competition for space on the rock faces.

Lower littoral zone remains submerged even during normal low tides and is rarely exposed during lowest low tides. This zone is also rich in flora and fauna.

Lichens are combination of algae and fungus. They grow slowly and can survive harsh conditions.

3. Marine Water Ecosystem

It is the largest habitat on the earth. Depth of ocean water is the greatest factor for the change in species of organisms. Broadly, the oceanic habitat can be divided into three parts:

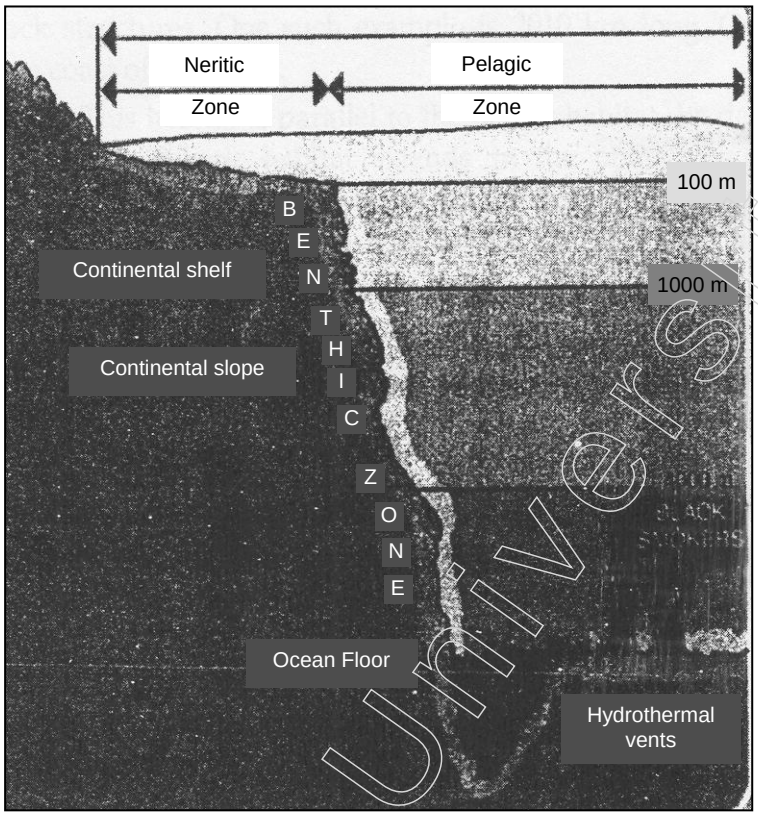

Fig. 3.14: Neritic, Pelagic and Benthic Ecosystem

(a) Neritic ecosystem
(b) Pelagic ecosystem
(c) Benthic ecosystem

(a) Neritic Ecosystem: Neritic zone is the open water of the continental shelf. It is a shallow water zone. Therefore, it receives maximum sunlight. As a result, it is the most productive zone of all the parts of ocean. It is ideal place for the growth of plankton which is food for many sea animals. Phytoplankton and zooplankton are the two types of plankton. Free swimming fish and other sea animals are in abundance.

Large variety of mollusks is found here like oyster, snail, slug, cockle and octopus. More than 50,000 species of mollusks are found. Mollusks are soft-bodied invertebrate animals.

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Variety of algae is found here. Algae are a group of plant like organisms. Algae can survive even in tough conditions like extreme cold and depth. Important types of algae are red algae, green algae and brown algae.

Kelps are popular plants in the inter-tidal zone. These plants are more prominent in the rocky shores. These are edible plants and are staple food in some parts of the world. Extracts from these plants are also used in the cosmetics and ice-creams.

Kelp plant has root like holdfast that fixes to the rock surface and makes food by photosynthesis. Sponges flourish in species in the sea water. They belong to the category of invertebrate animals with many body shapes but tube shape is common. They are hollow from inside and these cavities offer shelter for other sea animals like crab, stars, etc.

Another popular organism specially of the tropical waters is coral. It is a common name given to a group of invertebrate animals. Individual coral size is 1 to 3 mm in diameter. They exist in colonies. Continuous deposition of the skeletons of coral makes huge rock structures. One such example is 'Great Barrier Reef' along the Eastern Coast of Australia.

(b) Pelagic Ecosystem: This habitat is parallel to the neritic habitat. Its depth is same as in the neritic habitat, but pelagic habitat extends in the open seas and not on the continental shelf. Abundant sunshine helps in the growth of plankton. Here, free swimming animals are common like fish, shark, whale, jellyfish, dolphin, tortoise, etc.

Jellyfish is an invertebrate animal with many stings. Its stings are so painful that a man can die. Its stinging tentacles can be as long as 20 metres. Whale has 79 known species. Blue whale is the largest creature on earth. Its length may extend to 29 metres. Dolphins and porpoises appear similar. The only difference is that dolphins have beak like snout and porpoises have flat snout.

(c) Benthic Ecosystem: Deeper parts of ocean make benthic habitat. It extends from continental slope and beyond or just below the pelagic habitat. Deepest sea floor is also its part. It is a sparsely populated habitat due to absence of light. The number of organisms decreases towards the bottom. Sea lily is common in the tropical seas. It has disc-shaped body with feathery arms. They are brilliantly colored and are also known as feather stars. Squid is another organism of benthic ecosystem. It has cigar-shaped body with large head. It is normally 30 cm long, but giant squid grows up to 18 metres. It lives from 1000 to 2000 feet below sea level where it becomes food for the whales which dive up to this depth.

A little life is expected at the deep-sea plain which is cold and dark. But a unique type of organism grows at the sea floor also. It is the autotrophic bacteria around hydrothermal vents that are like spring of hot water in the deep-sea plain. The ejected water is very rich in sulphur. Around 80 such vents have been found in the Pacific Ocean.

3.16 Summary

Ecosystem is a region in which the living organisms interact with their environment. It is usually divided into two divisions, terrestrial and aquatic. The sequence of eating and being eaten in an ecosystem is known as food chain. A network of food chains where organisms connect at different trophic levels is a food web. The food webs give better constancy to ecosystems. A graphic representation of a trophic structure is known

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as ecological pyramid. At all levels in a pyramid, there is transfer of energy without which there could be no life.

3.17 Check Your Progress

I. Multiple Choice Questions

1. Ecosystems is _____.
   (a) Made up of only biotic factors
   (b) Made up of only abiotic factors
   (c) Found only on large areas
   (d) Made up of biotic and abiotic factors
2. During day time, in the procedure of photosynthesis by plants, _____ is released into the atmosphere.
   (a) Nitrogen
   (b) Oxygen
   (c) Helium
   (d) Carbon dioxide
3. Vegetation comes at _____ of the ecological pyramid.
   (a) the top
   (b) mid part
   (c) the base
   (d) the tip of the top
4. In India, the forest occupies roughly _____% of the total area.
   (a) 33
   (b) 19
   (c) 40
   (d) 11
5. Land ecosystem, water ecosystem and environmental ecosystems are _____ ecosystem.
   (a) Man-made
   (b) Natural
   (c) Plateau
   (d) Marine

3.18 Questions and Exercises

1. Define the following:
   (a) Ecosystem (b) Food chain
   (c) Food web (d) Ecological pyramid
2. Briefly explain ecosystem regulation.
3. Discuss the models of energy flow in an ecosystem.
4. Briefly explain energy flow in an ecosystem.

3.19 Key Terms

- **Organism:** It is a living thing like plant, animal or microorganism (microbe).

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- **Cell:** It is the elementary unit of living thing. It is the smallest independently functioning unit in the structure of an organism. Most organisms have numerous cells. Some are single-celled organism like bacterium.
- **Species:** It is a set of organisms that resemble each other in appearance and behaviour. Organisms of a species are capable of reproducing among themselves and generally organisms of the different species do not inter-breed, and even if they do, fertile offspring is not produced.
- **Population:** When members of the same species live and interact in a specific topographical zone, they are called population.
- **Community:** It is an assemblage of all interacting population of different species living in one geographical area.
- **Ecosystem:** It is a community of organisms interrelating with one another and with their environment.
- **Trophic:** The trophic level of an organism is the position it occupies in the food chain.

3.20 Check Your Progress: Answers

I. Multiple Choice Questions

Question	Answer
1	(d)
2	(b)
3	(c)
4	(b)
5	(b)

3.21 Further Reading and References

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Module III: Environmental Pollution

Unit IV: Environmental Pollution

Structure:

Objectives

After studying this unit, you should be able to:

- Define and know causes and effects of various types of pollution
- Describe the primary pollution of air, water and soil
- Understand that there are marine, noise, thermal and nuclear pollution as included in laws
- Explain the causes, effects and control of waste and its management
- Write about disaster management for floods, earthquakes, etc.

4.1 Introduction

Ecological contamination is caused due to an outcome of unwanted alterations to our environment which leave damaging impacts on varieties of floras, faunas and other life-forms. An element, which creates effluence, is identified as toxin. Toxins can be solid, in fluid state or vaporous elements that exist in larger concentration than in natural amount. They are formed because of human actions or due to natural activities. An interesting fact says, an average human being needs approximately 12-15 times extra

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air than food. So, even minor quantities of toxins in the air turn substantial if compared with parallel stages existing in eatables. Impurities can be degradable, like waste vegetables which speedily breakdown by natural procedures. On the flip side, chemicals which gradually degrade, stay back in the atmosphere and remain in an unaffected state for several years. For instance, elements like Dichloro Diphenyl Trichloroethane (DDT), plastic substances, metals, numerous pollutants, atomic chemicals, etc. as soon as are let out into the atmosphere become tough to eradicate. These toxins are impossible to degrade through natural procedures and harmfully affect multiple life-forms. During the course of ecological contamination, toxins are rooted up from a single source and get transmitted by air or water or are disposed into the soil by human beings.

4.2 Air Pollution

The aerosphere which borders the earth is hot and has equal viscosity at all altitudes. There are coaxial coatings of air or regions and every coating has varied thickness. The bottom-most section of atmosphere in which the human beings along with other life-forms exist is termed as **troposphere**. It outspreads up to the height of 10 km from sea level. Above the troposphere, between 10 and 50 km above sea level lies **stratosphere**. Troposphere is a stormy, grimy zone comprising of air, water vapors and clouds. This area includes sturdy air circulation and cloud construction. The stratosphere, on the other hand, contains dinitrogen, dioxygen, ozone and slight water vapor.

Atmospheric contamination is usually studied as tropospheric and stratospheric effluence. The existence of ozone in the stratosphere averts nearby 99.5% of the sun's damaging ultraviolet (UV) particle emission from falling on the earth's surface and by doing so, it protects humans and other living organisms from its outcomes.

1. Tropospheric Pollution

Tropospheric contamination happens because of the existence of unwanted hard or vaporous elements in the air. The following are the main vaporous and particulate matter toxins that are existing in the troposphere:

(a) Gaseous Air Pollutants: These are oxides of sulphur, nitrogen and carbon, hydrogen sulphide, hydrocarbons, ozone and other oxidants.

(b) Particulate Pollutants: These are dust, mist, fumes, smoke, smog, etc.

(a) Gaseous Air Pollutants

(i) Oxides of Sulphur: Oxides of sulphur are formed when sulphur comprising remnant fuel is burnt. The highly ordinary species – sulphur dioxide is a gas that is lethal to both, floras and faunas. It has been stated that even a little concentration of sulphur dioxide results in breathing illnesses, e.g., asthma, bronchitis, emphysema in human beings. Sulphur dioxide causes irritation to the eyes, resulting in tears and redness. High concentration of SO_2 leads to stiffness of flower buds which eventually fall off from plants. Uncatalyzed corrosion of sulphur dioxide is slow. Though, the existence of particulate matter in toxic air catalyzes the corrosion of sulphur dioxide to sulphur trioxide.

$$2SO_2\,(g) + O_2\,(g) \rightarrow 2SO_3\,(g)$$

The reaction can also be encouraged by ozone and hydrogen peroxide.

$$SO_2\,(g) + O_3\,(g) \rightarrow SO_3\,(g) + O_2\,(g)$$

$$SO_2\,(g) + H_2O_2\,(1) \rightarrow H_2SO_4\,(aq)$$

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(ii) Oxides of Nitrogen: Dinitrogen and dioxygen are the foremost elements of air. These vapors never counter with one another at a normal temperature. At high elevations after lightning attacks, they mix together and create oxides of nitrogen. NO_2 is oxidized to nitration, NO_3 is eroded into soil and thereby it helps as a manure. In a vehicle machine (at high temperature) when remnant fuels are burnt, dinitrogen and dioxygen mix together to produce substantial amounts of nitric oxide (NO) and nitrogen dioxide (NO_2) as given below:

$$N_2(g) + O_2(g) \xrightarrow{1483K} 2NO(g)$$

NO reacts rapidly with oxygen to form NO_2.

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

The speed of creation of NO_2 is quicker when nitric oxide reacts with ozone in the stratosphere.

$$NO(g) + O_3(g) \rightarrow NO_2(g) + O_2(g)$$

The irritation of red haze in the traffic and congested places is due to oxidization of nitrogen. Higher concentrations of NO_2 harm the leaves of floras and retard the speed of photosynthesis. Nitrogen dioxide is a lung pain which can result in severe breathing illness in kids. It is poisonous to living tissues also. Nitrogen dioxide is also damaging to numerous textile fibres and metals.

(iii) Hydrocarbons: Hydrocarbons consists of just hydrogen and carbon, and are created by partial burning of fuel used in cars. Hydrocarbons are carcinogenic, i.e., they are the source of cancer diseases. They damage floras by triggering ageing, breakdown of tissues and shedding of leaves, flowers and twigs.

(iv) Oxides of Carbon:

- **Carbon Monoxide:** Carbon monoxide (CO) is a gas leading to severe hazards and resulting in dangerous airborne toxins. It is a colorless and odorless gas, which is extremely lethal to several life-forms because of its capacity to stop the distribution of oxygen to the organs and tissues. It is created due to unfinished burning of carbon. Carbon monoxide is largely let out into the air by vehicle consumption. Different other causes that create CO include partial burning of coal, firewood, petrol, etc. The extent of automobiles has rapidly increased globally since many years now. A lot of these automobiles are badly kept and many of them have insufficient effluence controller equipment. Hence, this results in massive amount of Carbon Monoxide and other harmful gases that gets released out into the atmosphere, which increases the pollution by 3% to 4% and the oxygen circulating ability of blood is highly decreased. This oxygen deficit causes headaches, bad eye vision, anxiety and cardiac sickness. This being one of the major reasons people are constantly recommended to quit smoking. Pregnant females who have the habit of smoking are at a high risk of severe increase of CO level in blood, which may result in untimely birth, impulsive miscarriages and malformed children.
- **Carbon Dioxide:** Carbon dioxide (CO_2) is let out into the environment by breathing, burning of fossil fuels for energy, and by breakdown of limestone during the production of cement. CO_2 also gets released after volcanic eruptions. The limitations of Carbon Dioxide gas are only up to the troposphere level. Usually, it comprises of about 0.03% by capacity of the atmosphere. As the consumption of fossil fuel is increased, a massive quantity of carbon dioxide gets emitted into the environment. Additional carbon dioxide in the air is treated by green floras and this

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process upholds an apt level of CO_2 in the environment. Green floras need CO_2 for photosynthesis and they, in return, release oxygen, therefore sustaining the subtle stability. As a lot of us are already aware, deforestation and burning of fossil fuel upsurges the CO_2 levels and interrupts the steadiness in the environment. The amplified quantity of CO_2 in the air is primarily accountable for Global Warming.

Global Warming and Greenhouse Effect

Out of the total solar energy reaching the earth, about 75% of this energy is soaked in by the earth's surface, which rises its temperature. The remaining solar energy emits into the environment. Some amount of heat is stuck by vapors like carbon dioxide, methane, ozone, chlorofluorocarbon compounds (CFCs) and water vapor in the atmosphere. Therefore, they increase the heating of the environment. This is the main cause of Global Warming.

As we all are aware of that, in snowy regions floras, vegetables and fruits are planted in glass enclosed zones, which is denoted as greenhouse. Were you aware that we humans, too, live under a greenhouse? It is obvious that we are not encircled by glass but a massive cover of air named the atmosphere, which has sustained the temperature on earth continuously since numerous eras. But our atmosphere is now experiencing tremendous changes, however slowly. Just like how the glass in a greenhouse grasps the sun's warmth inside, similarly, atmosphere holds the heat of the sun close to the surface of the earth and retains its warmth. This is termed as *natural greenhouse effect* as it preserves the temperature and perfectly prepares the earth for several life-forms. In a greenhouse, evident light permits through the translucent glass and increases the warmth in the mud and floras. The heated mud and floras release ultraviolet energies. Since glass is opaque to ultraviolet (heat) energies, it partially reflects and partially soaks these energies. This procedure saves the energy of the sun blocked in the greenhouse. Likewise, carbon dioxide particles too, block warmth as they are see-through to sunrays but not to the hot radioactivity. If the total of carbon dioxide goes beyond the subtle amount of 0.03%, the natural greenhouse stability will get distressed. Carbon dioxide gas largely contributes to Global Warming.

Apart from carbon dioxide, additional greenhouse vapors are methane, water vapor, nitrous oxide, CFCs and ozone. Methane is formed naturally when plants are burnt, consumed or decomposed without the presence of oxygen. Bulky quantities of methane are emitted in paddy fields, coal mines, from decomposing trash heaps and by fossil fuels. Chlorofluorocarbons (CFCs) are synthetic manufacturing elements that are implemented in air conditioning, etc. CFCs, too, are destructing the ozone coating. Nitrous oxide is found naturally in the atmosphere. In the past few decades, their numbers have amplified rapidly because of the application of toxic pesticides and the burning of remnant fuels. If such tendencies remain to be in action, the typical worldwide temperature will upsurge to an extent, that will result in melting of polar ice caps and flooding of lowland zones spreading entirely over the earth. Rise in the worldwide temperature upsurges the occurrence of transferable illnesses like dengue, malaria, yellow fever, sleeping sickness, etc.

Control of Global Warming

Burning of remnant fuels, chopping off woodlands and vegetation increase greenhouse vapors in the environment, it is obligatory to search for solutions and implement them proficiently and sensibly. One of the easiest solutions that can be applied to decrease Global Warming is to cut the use of vehicles to minimum. Reliant upon the condition, a person can take the cycle, civic transportation arrangement, or opt

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for carpool. More trees should be planted by all of us to grow the green cover. Do not burn dry leaves, wood, etc. It is unlawful to smoke in communal and office locations, as it is damaging for other people who are present at that particular place and also for the person who is smoking. Hence, people are advised to stay away from it. A lot of individuals do not comprehend the greenhouse result and the Global Warming and it Is our duty to help such people by sharing right knowledge.

(b) Particulate Pollutants

Particulate Matter Toxins: Particulate matter toxins are the tiny hard elements or fluid precipitations in the air. They exist in automobile emanations and gaseous substances arising from burning, dirt matter and residues from manufacturing industries. Particulate matter in the environment can be feasible or non-feasible. The feasible particulate matter, e.g., microorganisms, fungus, molds, algae, etc. are microscopic life-forms which spreads in the environment. We humans are hypersensitive to a few of the funguses occurring in the air. These bacterial formations also result in vegetal illnesses.

Non-feasible particulate matter can be categorized as per their nature and size as follows:

(i) Fume particulate matter are made up of hard or combination of hard and fluid substances that are created at the time of burning of biological materials. For instance, cigarette smoking, fumes from combustion of remnant fuel, trash and parched plants, oil fumes, etc.

(ii) Dirt is made up of tiny hard elements and are formed at the time of crushing, grinding and attribution of hard things. Sand from sand blasting, saw dust from shaping or cutting wooden logs, crushed coal, cement and fly ash from workshops, dust storms, etc. are a few instances of minute particulate matter release.

(iii) Fogs are formed by elements of spray fluids and through compression of fumes in the air. For example, sulphuric acid haze and herbicides and pesticides that fail their goals and float in air to create fogs.

(iv) Gases are usually found after the liquefaction of fumes at the time of sublimation, purification, boiling and many additional biochemical reactions. Usually, biological diluters, metals and metallic oxides produce gaseous elements.

The consequence of particulate matter toxins is mainly dependant on the element proportions. Floating elements like dirt, gases, fog, etc. create health hazardous for human beings. Particulate matter toxins larger than 5.0 micron are most probably to lodge in the nasal passage. However, elements of almost 1.0 micron pass in through the lungs effortlessly.

Lead is a foremost air toxin released by automobiles. Leaded petrol was once a prime cause of air-borne lead release in Indian towns. This issue now has been overpowered by utilizing unleaded petrol in maximum towns of India. Lead hinders the growth and maturing of red blood cells.

2. Stratospheric Pollution

Formation and Breakdown of Ozone

The uppermost stratosphere comprises of substantial quantity of ozone (O_3), which shields us from the damaging infrared (UV) pollutions (λ 255 nm) approaching from the sun. These contaminations result in skin cancer (melanoma) in human beings. Thus, it is significant to preserve the ozone armor.

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Ozone in the stratosphere is a creation of infrared contaminations, which come into action by dioxygen (O_2) particles. The infrared contaminations divide separately the molecular oxygen into free oxygen (O) atoms. These oxygen atoms mix with the molecular oxygen to create ozone.

$$O_2\,(g) \xrightarrow{UV} O(g) + O\,(g)$$

$$O\,(g) + O_2\,(g) \xrightarrow{UV} O_3\,(g)$$

Ozone is thermodynamically unbalanced and decays to molecular oxygen. Therefore, an active steadiness occurs amongst the making and breakdown of ozone molecules. In the past few years, it is been documented that the exhaustion of this protecting ozone layer is due to the existence of some specific toxic elements in the stratosphere. The foremost cause of ozone layer reduction is supposed to be the emission of chlorofluorocarbon compounds (CFCs). They are termed as freons. These mixtures are chemically inert, incapable of combustion, harmless biological particles and are consequently utilized in fridge freezers, air conditioners, in manufacture of plastic foam and by the electrical businesses for scrubbing computer portions, etc. When CFCs are emitted in the environment, they combine with the usual atmospheric vapors and ultimately spread to the stratosphere. In stratosphere, they get broken down by strong infrared particle emissions, which let out chlorine-free radical.

$$CF_2Cl_2\ (g) \xrightarrow{UV} \dot{C}l\ (g) + \dot{C}F_2Cl\ (g) \quad \text{... (i)}$$

The chlorine radical then reacts with stratospheric ozone to form chlorine monoxide radicals and molecular oxygen.

$$\dot{C}l\,(g) + O_3\,(g) \rightarrow Cl\acute{O}\,(g) + O_2\,(g) \quad \text{... (ii)}$$

Reaction of chlorine monoxide radical with atomic oxygen produces more chlorine radicals.

$$Cl\acute{O}\,(g) + O\,(g) \rightarrow \dot{C}l\,(g) + O_2\,(g) \quad \text{... (iii)}$$

The chlorine radicals are repeatedly redeveloped and result in the collapse of ozone. Hence, CFCs are transferring agents for non-stop creation of chlorine radicals into the stratosphere and destructing the ozone layer.

4.3 Sources of Air Pollution and Air Pollutants

Air pollution results from gaseous emissions from mainly industry, thermal power stations, automobiles, domestic combustion, etc.

Industrial Chimney Wastes

There are a number of industries which are source of air pollution. Petroleum refineries are the major source of gaseous pollutants. The chief gases are SO_2 and NO_x. Mathura-based petroleum refinery is posing threat to Taj Mahal in Agra and other monuments at Fatehpur-Sikri Complex. Cement factories emit plenty of dust, which is potential health hazard. Stone crushers and hot mix plants also create a menace. The SPM levels in such areas of stone crushing are more than five times the industrial safety limits. There are many food and fertilizer industries which emit gaseous pollutants. There are also chemical manufacturing industries which emit acid vapors in air. During last 20 years or so, the number of industrial units in Delhi increased many folds and several thousand of these are located in predominantly residential area in Najafgarh Road, Lawrence Road, Wazirpur, Kirti Nagar, DLF Industrial Area and Moti Nagar. These areas have chemical, fertilizer, iron and steel rolling units. These units emit large

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amounts of SO_2, dust and SPM over large areas. One can imagine the kind of air inhaled by the residents of the localities surrounding these industrial units.

Thermal Power Stations

There are a number of thermal power stations and super thermal power stations in the country. The National Thermal Power Corporation (NTPC) is setting up four mammoth coal-powered power stations to augment the energy generation. These are at Singrauli in UP, Korba in MP, Ramagundam in Andhra Pradesh and Farakka in West Bengal. The coal consumption of thermal plants is several million tons. The chief pollutants are fly ash, SO_2, and other gases and hydrocarbons.

The three thermal power stations at the Indraprastha Estate, Rajghat and Badarpur in Delhi are the main source of air pollution. The Indraprastha plant daily consumes roughly 5,000 tons of coal when all the five units function Badarpur, the largest consumes about 10,000 tons of coal daily.

Automobiles

The toxic vehicular exhausts are a source of considerable air pollution, next only to thermal power plants. The ever increasing vehicular traffic density posed continued threat to the ambient air quality. In India, the number of automobiles is increasing in metro cities and other urban areas (Fig. 4.1). In the major metropolitan cities, vehicular exhaust accounts for 70% of all CO, 50% of all hydrocarbons, 30-40% of all oxides and 30% of all SPM. During peak traffic hour, automobiles of all classes emit large amount of CO, hydrocarbons and nitrogen oxides. The two-wheelers and three-wheelers contribute 60% of the total CO and 83% of total hydrocarbons, whereas heavy traffic vehicles 55% to 80% of the oxides of nitrogen. It is estimated that a car (without cleaning device) on burning 1000 litre of fuel emits 350 kg CO, 0.6 kg SO_2, 0.1 kg lead and 1.5 kg SPM. About 1000 gallons of petrol after combustion produces 3200 lb of CO, 200-400 lb organic vapors, 20-75 of NO_x, 18 lb of aldehydes, 17 lb of sulphur compounds, 2 lb of organic acids and NH_3 each and 0.3 lb of solid carbons.

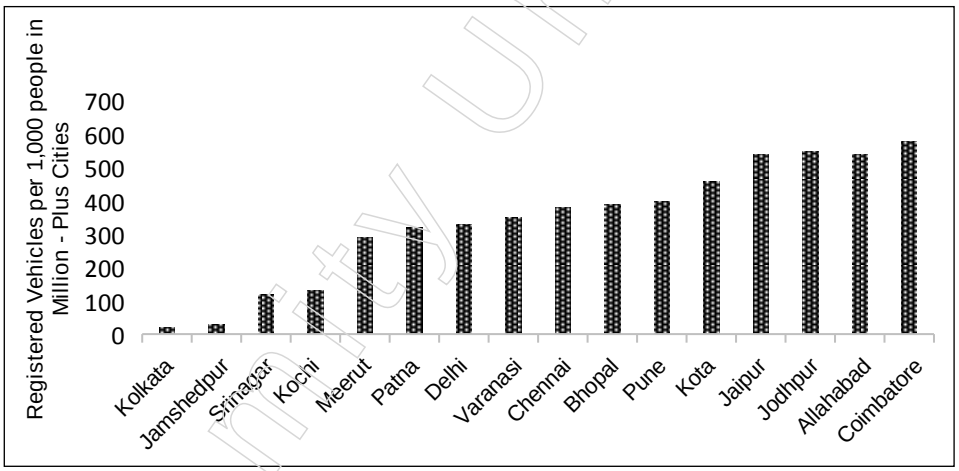

Fig. 4.1: Registered Motor Vehicles in Indian Cities in the Year 2011

Source: Based on data of Union Ministry of Road Transport and Highways, 2012

Chief sources of emission in automobiles are: (i) exhaust system, (ii) fuel tank and carburettor and (iii) crankcase. The exhaust produces many air pollutants including unburnt hydrocarbons, CO, NO_x and lead oxides. There are also traces of aldehydes, esters, ethers, peroxides and ketones which are chemically active and combine to form

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smog in present of light. Evaporation from fuel tank goes on constantly due to volatile nature of petrol, causing emission of hydrocarbons. The evaporation through carburettor occurs when engine is stopped and heat builds up, and as much as 12-40 ml of fuel is lost during each long stop causing emission of hydrocarbons. Some gas vapor escapes between walls and the piston, which enters the crank case and then discharges into the atmosphere. This accounts for 25% of the total hydrocarbon emissions of an engine.

From the different sources of air pollution, a variety of pollutants are released into atmosphere. The principal air pollutants emitted from these different sources are as follows:

1. **Carbon Compounds:** These are mainly CO_2 and CO, the former released by complete combustion of fossil fuels and the latter by automobile exhausts.
2. **Sulphur Compounds:** These include SO_2, H_2S and H_2SO_4, mostly released by fossil fuel (coal, etc.) based power generating plants (thermal plants) and industrial units as refineries.
3. **Nitrogen Oxides:** These include chiefly NO, NO_2, HNO_3, mostly released by automobiles, power plants and industries.
4. **Ozone (O_3):** Its level may rise in atmosphere due to human activities.
5. **Fluorocarbons:** These come from industries, insecticides spray, etc.
6. **Hydrocarbons.** These are chiefly benzene, benzpyrene, etc. which are mostly discharged by automobiles and industries.
7. **Metals:** These include chiefly lead, nickel, arsenic, beryllium tin, vanadium, titanium, cadmium, etc. present in air as solid particles or liquid droplets or gases. They are produced mostly by metallurgical processes, automobiles, seaspray, etc.
8. **Photochemical Products:** These are the photochemical smog, PAN, PBzN, etc. released mostly by automobiles.
9. **Particular Matter:** These are fly ash, dust, grit and other suspended particulate matter (SPM) released from power plants and industries (stone crushers, etc.). There are also bacterial cells, fungal spores and pollens in air as biological particulate pollutants. **Aerosols** have become the major air pollutants.
10. **Toxicants Other than Metals:** These are complex chemical substances released during manufacture of other goods.

4.4 Methods to Control Air Pollution

Harmful Effects of Air Pollutants

A new global review of the burden of diseases, carried out by 450 experts in a consortium partners, including the WHO and led by the Institute for Health Metrics and Evaluation (IHME), ranked exposure to air pollution as one of the top 10 risk factors for health all over the world. The India-specific findings of this Global Burden of Disease (GBD) assessment released in February 2013 showed air pollution as the fifth largest killer in India. The public health implications of the heavily polluted air in Indian cities became much evident in June 2013 when the International Agency for Research on Cancer classified outdoor air pollution and particulate matter as Class 1 carcinogens and the leading environment causes of lung cancer deaths. As per CSE, Delhi report only two towns in Kerala, Malappuram and Pathanamthitta, meet the clean air benchmark of the CPCB. As per the latest available air quality data from the CPCB, nearly half of total urban population of India is exposed to air quality that exceeds the

standards of PM_{10}. whereas one-third of our urban population lives in cities with PM_{10} levels classified as critical.

General Methods of Prevention and Control of Air Pollution

For ages, man has been dumping wastes into the atmosphere, and these pollutants have disappeared with the wind. We have seen that the main sources of air pollution are: (i) motor vehicles, (ii) industries—particularly their chimney wastes, (iii) fossil fuel (coal) based plants as thermal power plants. Steps are to be taken to control pollution at source (prevention) as well as after the release of pollutants in the atmosphere. There is an urgent need to prevent the emissions from the above-said major sources of air pollution.

The control of emissions can be realized in number of ways. Five separate possibilities for control of air pollutants are shown in Fig. 4.2. These are briefly considered below.

1. Source Correction

This is the easiest solution to air pollution problem, where we stop the guilty process. Hence, it is also called **prevention.** The engineer must consider the possibility of controlling the emissions by changing the process. For instance, if automobiles are found to release high lead levels in air, the most reasonable solution is simply to eliminate the lead in the gasolines. The source has been corrected and the problem solved. In addition to a change of raw material, a modification of the process might also be used to achieve a desired result. For example, municipal refuse incinerators are known to stink. The odors can often be readily controlled if the incinerators are operated at a high enough temperature to completely oxidize the organics which cause the odor. Strictly speaking, such measures as process change, raw material conversion or equipment modification to meet emission standards are known as **controls**. In contrast, **abatement** is the term used for all devices and methods for decreasing the quantity of pollutants reaching the atmosphere, once the stuff has already been emitted from the source. In a wider sense and for simplicity, it is better to refer to all of the procedures as controls.

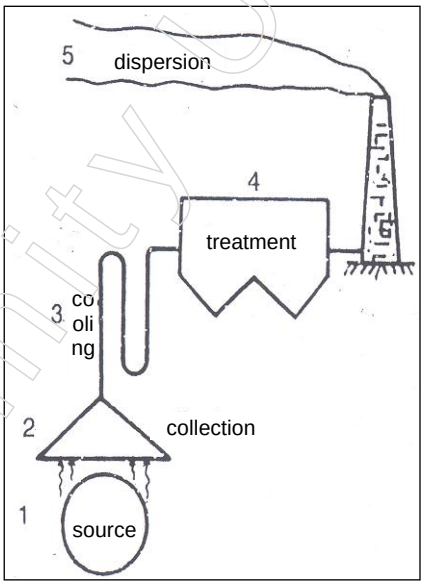

Fig. 4.2: Five Points of Control of Possible Emission of Air Pollutants

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2. Collection of Pollutants

Often, the most serious problem in air pollution control is the collection of the pollutants so as to provide treatment. Automobiles are most dangerous, but only because the emissions cannot be readily collected. If we could channel the exhausts from automobiles to some central facilities, their treatment would be much more reasonable than controlling each individual car.

One success in collecting pollutants has been the recycling of blow by gases in the internal combustion engine. By reigniting these gases and emitting them through the car's exhaust system, the need of installing a separate treatment device for the car can be eliminated.

Air pollution control engineers have their toughest time when the pollutants from an industry are not collected but emitted from windows, doors and cracks in the walls.

3. Cooling

The exhaust gases to be treated are sometimes too hot for the control equipment and the gases must first be cooled. This can be done in three general ways: dilution, quenching, or heat exchange coils. Dilution is acceptable only if the total amount of hot exhaust is small. **Quenching** has the additional advantage of scrubbing out some of these gases and particulates. The cooling coils are perhaps the most widely used, and are especially appropriate when heat can be conserved.

4. Treatment

The selection of the correct treatment device requires the matching of the characteristics of the pollutant and the features of the control device. It is important to realize that the sizes of air pollutants range many orders of magnitude, and it is therefore not reasonable to expect one device to be effective for all pollutants. In addition, the types of chemicals in emissions will often dictate the use of some devices. For example, a gas containing a high concentration of SO_2 could be cleaned by water sprays, but the resulting H_2SO_4 might present serious corrosion problems.

Although any new devices may appear any day in the market, the following are the most widely used:

Setting Chambers: They are nothing more than large places in the flues, similar to settling tanks in water treatment. These chambers remove only the large particulates.

Cyclones: They are widely used for removing large particulates. The dirty air is blasted into a conical cylinder, but off the centerline. This creates a violent swirl within the cone, and the heavy solids migrate to the wall of the cylinder where they slow down due to friction and exit at the bottom of the cone. The clean air is in the middle of the cylinder and exist out the top. Cyclones are widely used as pre-cleaners to remove the heavy material before further treatment.

Bag Filters: They operate like the common vacuum cleaner. Fabric bags are used to collect the dust which must be periodically shaken out of the bags. The fabric removes nearly all particulates. Bag filters are widely used in many industries, but are sensitive to high temperature and humidity.

Wet Collectors: They come in many shapes and styles. The simple spray tower (Fig. 4.3) is an effective method for removing large particulates. More efficient scrubbers promote the contact between air and water by violent action in a narrow throat section into which the water is introduced. Generally, the more violent the encounter, and hence the smaller the gas bubbles or water droplets, the more effective the scrubbing.

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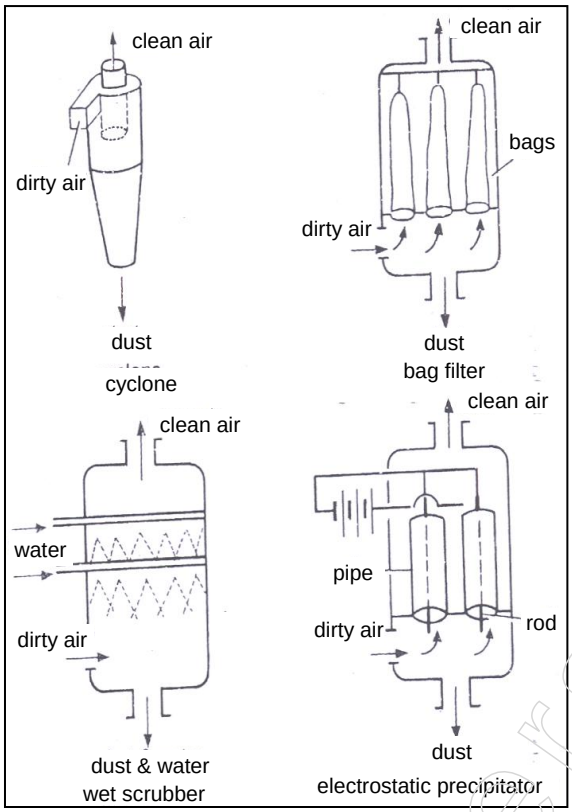

Fig. 4.3: Wet Collectors and Electrostatic Precipitators for Control of Particulates of Air Pollution

Electrostatic Precipitators: They are widely used in power plants. The particulate matter is removed by first being charged by electrons jumping from one high voltage electrode to the other, and then migrating to the positively charged electrode. One type as shown in Fig. 4.3 consists of a pipe with a wire hanging down the middle. The particulates will collect on the pipe and must be removed by banging the pipes with hammers. Electrostatic precipitators have no moving parts, require electricity, and are extremely effective in removing submicron particulates. They are expensive.

Gas Scrubbers: They are simply wet collectors as described above, but are used for dissolving the gases.

Adsorption: It contains material such as activated carbon to capture pollutants. Such absorbers may be expensive to regenerate. Most of these work well for organics and have limited use for inorganic pollutants.

Incineration: This is a method for removing gaseous pollutants by burning them to CO_2, H_2O and inerts. This works only for combustible vapors.

Catalytic Combustion: This involves the use of a catalyst to adsorb or chemically change the pollutants.

It is again important to emphasize the dependence of effectiveness of a treatment device on particle size.

5. Dispersion

The science of meteorology has great bearing on air pollution. An air pollution problem involves three parts – the source, the movement of the pollutant, and the recipient. The concentration of the pollutants at the recipient is affected by atmospheric

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dispersion, or how the pollutant is diluted with clean air. This dispersion takes place horizontally as well as vertically. Earth rotation presents new areas for the sun to shine upon and to warm air. Accordingly, a pattern of winds is set up around the world, some seasonal (e.g., hurricanes) and some permanent. Air pollution engineers often use a variation of the wind rose (a wind rose are graphic pictures of wind velocity and direction data), called a **pollution rose** to determine the source of a pollutant.

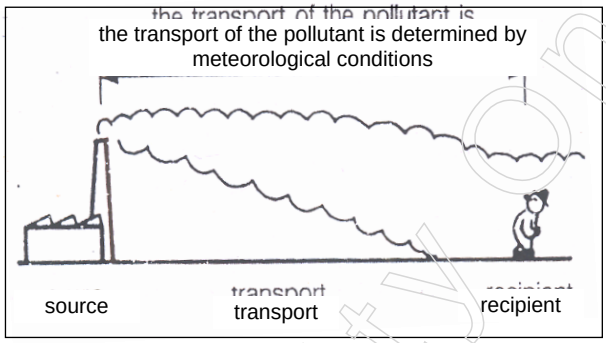

Fig. 4.4: Meteorology and Air Pollution

4.5 Acid Rain

As we are mindful that typically rain water has a pH of 5.6 because of the existence of H^+ ions created by the reaction of rain water with carbon dioxide existing in the environment.

$$H_2O\,(l) + CO_2\,(g) \rightleftharpoons H_2CO_3\,(aq)$$

$$H_2CO_3\,(aq) \rightleftharpoons H^+\,(aq) + HCO_3\,(aq)$$

When the pH of the rain water goes less than 5.6, it is termed as acid rain.

Acid rain denotes the methods through which the acid from the environment is left on the surface of the earth. Oxides of nitrogen and sulphur that are naturally acidic can be carried away by breeze with hard elements in the environment and ultimately remain upon either the ground as dry deposition or in water, fog and snow as wet deposition.

Acid rain is a result of variations in human actions that release the oxides of sulphur and nitrogen in the environment. As it was stated previously, burning of remnant fuels (that comprise of sulphur and nitrogenous substances) such as coal and oil in power stations and furnaces or petrol and diesel in vehicle engines form sulphur dioxide and nitrogen oxides. SO_2 and NO_2 later oxidize and react with water, and mainly contribute in acid rains, as contaminated air typically holds particulate matter that catalyze the corrosion.

$$2SO_2\,(g) + O_2\,(g) + 2H_2O\,(l) \rightarrow 2H_2SO_4\,(aq)$$

$$4NO_2\,(g) + O_2\,(g) + 2H_2O\,(l) \rightarrow 4HNO_3\,(aq)$$

Ammonium salts, too, are created which can be observed as an atmospheric haze (aerosol of fine particles). Aerosol elements of oxides or ammonium salts in raindrops outcomes in wet deposition. SO_2, too, is soaked rightly on both, hard and fluid ground, tops and is therefore left as dry deposition.

Acid rain is destructive for farming, vegetation and floras as it melts and washes downs all nutrients required for their development. It causes breathing illnesses in humans and faunas. When acid rain drops and drifts towards ground water to reach rivers, lakes, etc., it disturbs floras and fauna life forms in marine ecology. It disintegrates water pipes ensuing in the discharge of hefty metals such as iron, lead and

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copper into the drinking water. Acid rain harms the constructions and different buildings made of stone or metal. The Taj Mahal in India has been affected by acid rain.

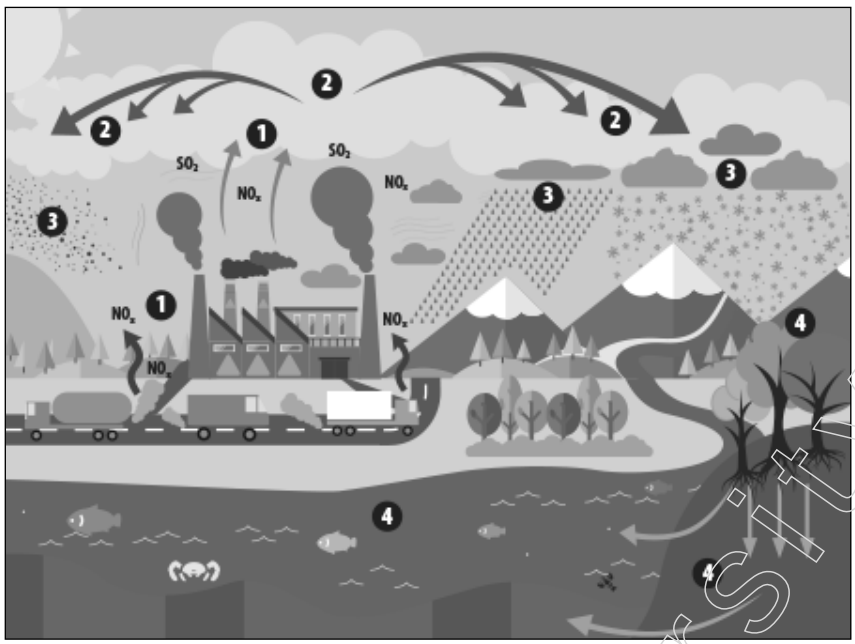

Fig. 4.5: Acid Deposition

Activity 1

One can gather samples of water from neighboring areas and note their pH standards. Converse about your recorded values in the class and discuss how can one take measures to help decrease the creation of acid rain.

This activity can be completed by dropping the release of sulphur dioxide and nitrogen dioxide in the environment. We must use fewer automobiles driven by fossil fuels, use limited sulphur content remnant fuels for power plants and manufacturing. We should use natural gas which is a better fuel compared to coal or use coal which has minimum sulphur quantity. Catalytic convertors should always be implemented in automobiles to lessen the result of exhaust gases in the environment. The foremost element of the convertor is a ceramic honeycomb coated with expensive metals – Pd, Pt and Rh. The exhaust smokes comprising of unburnt fuel, CO and NO_x, when permit through the convertor at 573 K, are transformed into CO_2 and N_2. We can also decrease the acidity of the soil by adding powdered limestone to neutralize the acidity of the mud. A lot of people are unaware of acid rain and its damaging outcomes. It is our duty to educate them by sharing the right knowledge and information to preserve the nature.

Taj Mahal and Acid Rain

The air surrounding the Agra city, where the Taj Mahal is situated, holds quite a lot of sulphur and nitrogen oxide deposits. It is primarily because of countless large-scale businesses and power plants located in the same vicinity. An extensive usage of bad quality of coal, kerosene and firewood as fuel for local reasons has doubled up this severe condition. The following acid rain showers responds with marble, $CaCO_3$ of Taj Mahal ($CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO$) and cause harm to this brilliant memorial which fascinates individuals internationally. Its outcome, being the memorial, is gradually becoming stained and the marble appears to be discolored and lusterless.

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The Government of India declared an action plan in early 1995 to avoid the scarring of this ancient memorial. Mathura Refinery has started to take appropriate actions to keep a check on the release of poisonous vapors.

The foremost purpose of this plan is to clear the air in the **'Taj Trapezium'** – a zone which consist of the townships of Agra, Firozabad, Mathura and Bharatpur. This particular plan states more than 2000 contaminating businesses are situated under the trapezium would make a shift to imply the usage of natural gas or liquefied petroleum gas (LPG) by replacing coal or oil. A new natural gas pipeline will carry extra than half a million cubic metres of natural gas per day to this zone. Individuals residing in the town, too, will be urged to make use of liquefied petroleum gas (LPG) and replace the use of coal, kerosene or firewood. Automobiles making use of highways in the locality of Taj will be urged to make use of minimum sulphur deposit diesel.

4.6 Smog: Sulphur, Photochemical and Industrial

The term smog is obtained from smoke and fog. This is a very usual example of air contamination that takes place in several countries all over the world.

(a) Sulphur: It is observed in cold tropical weather. It is a combination of fume, haze and sulphur dioxide. Chemically, it is a dropping blend. Hence, it is also termed as reducing smog.

(b) Photochemical Smog: It is observed in warm, parched and bright weather. The foremost substances of the photochemical smog upshot from the reaction of sunrays on unsaturated hydrocarbons and nitrogen oxides formed by vehicles and manufacturing units. Photochemical smog has strong concentrated oxidizing agents and is thus termed as oxidizing smog.

(c) Industrial Smog: It is combination of smoke, fog and chemical pollutants from industries.

Formation of Photochemical Smog

When remnant fuels are burnt, a variability of contaminants are released into the earth's troposphere. Two of the contaminants that are released are hydrocarbons (unburnt fuels) and nitric oxide (NO). When such toxins expand to adequately bulky stages, a chain reaction arises from their contact with sunrays in which NO is transformed into nitrogen dioxide (NO_2). This NO_2 in return soaks energy from sunbeams and breakdowns into nitric oxide and release oxygen atom (Fig. 4.2).

$$NO_2\ (g) \xrightarrow{hv} NO\ (g) + O\ (g) \quad \text{... (i)}$$

Oxygen atoms are most responsive and mix with the O_2 in air to create ozone.

$$O\ (g) + O_2\ (g) \rightarrow O_3\ (g) \quad \text{... (ii)}$$

The ozone created in the above reaction (ii) reacts speedily with the NO(g) shaped in the chemical reaction (i) to redevelop NO_2. NO_2 is a brown gas and at adequately large stages can promote the development of fog.

$$NO\ (g) + O_3\ (g) \rightarrow NO_2\ (g) + O_2\ (g) \quad \text{... (iii)}$$

Ozone is a poisonous vapor, and both NO_2 and O_3 are concentrated oxidizing agents and can respond with the unburnt hydrocarbons in the contaminated air to form toxic substances like formaldehyde, acrolein and peroxyacetyl nitrate (PAN).

Effects of Photochemical Smog

The usual elements of photochemical smog are ozone, nitric oxide, acrolein, formaldehyde and peroxyacetyl nitrate (PAN). Photochemical pollution results in severe hazards to health. Both ozone and PAN turn into strong eye pains. Ozone and nitric oxide infuriate the nose and throat, and their strong level of concentration results in headache, chest ache, dehydration of the throat, cough and trouble in respiration. Photochemical smog causes breaking of rubber and serious harm to the lives of trees. It also results in erosion of metallic element, pebbles, construction supplies, gum and coated exteriors.

How Can Photochemical Smog be Controlled?

Several methods are implied to regulate or decrease the creation of photochemical pollution. If we regulate the prime forerunners of photochemical pollution like NO_2 and hydrocarbons, the subordinate forerunners such as ozone and PAN, the photochemical pollution will spontaneously decrease. Typically, catalytic convertors are applied in vehicles which stop the emission of nitrogen oxide and hydrocarbons into the environment. Some kinds of floras like Pinus, Juniperus, Quercus, Pyrus and Vitis can absorb nitrogen oxide, and consequently, their farming will benefit in this issue.

4.7 The Ozone Hole

In 1980s, atmospheric scientists working in Antarctica stated with regards to the exhaustion of ozone layer usually called as ozone hole over the South Pole. It was observed that an exclusive set of circumstances were accountable for the ozone hole. In summer season, nitrogen dioxide and methane react with chlorine monoxide [reaction (iv)] and chlorine atoms [reaction (v)] creating chlorine sinks, averting ample ozone exhaustion, whereas in winter, distinct kinds of clouds termed as polar stratospheric clouds occur over Antarctica. These polar stratospheric clouds offer surface on which chlorine nitrate created [reaction (iv)] gets hydrolyzed to produce hypochlorous acid [reaction (vi)]. Similarly, it responds with hydrogen chloride formed as per reaction (v) to give molecular chlorine.

$$ClO\,(g) + NO_2\,(g) \rightarrow ClONO_2\,(g) \quad \text{... (iv)}$$

$$ClO\,(g) + CH_4\,(g) \rightarrow \dot{C}H_3\,(g) + HCl\,(g) \quad \text{... (v)}$$

$$ClONO_2\,(g) + H_2O\,(g) \rightarrow HOCl\,(g)\ HNO_3\,(g) \quad \text{... (vi)}$$

$$ClONO_2\,(g) + HCl\,(g) \rightarrow Cl_2\,(g) + HNO_3\,(g) \quad \text{... (vii)}$$

When sunbeams reoccur to the Antarctica in the spring, the sun's heat breaks down
the clouds and HOCl and Cl_2 are photolyzed by sunrays, as given in reactions (viii) and (ix).

$$HOCl\,(g) \xrightarrow{hv} OH\,(g) + \dot{C}l\,(g) \quad \text{... (viii)}$$

$$Cl_2\,(g) \xrightarrow{hv} 2\dot{C}l\,(g) \quad \text{... (ix)}$$

The chlorine radicals, consequently produced, start the chain reaction for ozone exhaustion as defined previously.

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Effects of Depletion of the Ozone Layer

By the exhaustion of ozone layer, additional infrared pollution sieves into troposphere. Infrared pollution results in aged skin, cataract, sun tan, skin cancer, death of several phytoplanktons, harm to aquatic production, etc. It is so specified that plant proteins get rapidly harmed by infrared pollution which results in damaging alteration of cells. It also upsurges evaporation of surface water through the stomata of the leaves and declines the moisture content of the soil. Rise in infrared pollution harm paints and fibres, triggering them to disappear quicker.

4.8 Water Pollution

Water is all so crucial to living beings. In the absence of water, no life shall exist. Water is frequently taken for granted by us. Our duty is to safeguard its cleanliness and protect the quality of water. Water contamination roots from the actions of human beings. By diverse routes, contamination spreads to the surface or ground water. Effortlessly recognized cause or home of effluence is termed as prime source, e.g., civic and manufacturing release pipes where toxins arrive in the natural water bodies. Non-point sources of effluence are those where a source of contamination is not recognized quickly, e.g., farming overflow (from ranch, animals and crop-lands), acid rain, storm-water drainage (from roads, car parks and grasslands), etc. Table 4.1 lists the foremost water toxins and their bases.

Table 4.1: Foremost Water Toxins

Pollutant	Source
Microorganisms	Domestic sewage
Organic Wastes	Domestic sewage, animal excreta and waste, decaying animals and plants, and discharge from food processing factories.
Plant Nutrients	Chemical fertilizers
Toxic Heavy Metals	Industries and chemical factories
Sediments	Erosion of soil by agriculture and strip
Pesticides	Chemicals used for killing insects, fungi and weeds
Radioactive Substances	Mining of uranium containing minerals
Heat	Water used for cooling in industries

Causes of Water Pollution

1. Pathogens: Very severe water contaminants and disease-causing agents are termed as pathogens. Pathogens consist of microorganisms and other creatures which reach the water through local sewage and animal excreta. Human excreta comprise of bacteria such as *Escherichia coli* and *Streptococcus faecalis* which result in intestinal sicknesses.

2. Organic Wastes: The additional foremost water contaminant are biological substances like leaves, grass, trash, etc. They contaminate water as a consequence of run-off. Extreme phytoplankton development inside the water is also one reason for water pollution. These wastes are decomposable.

The huge population of microorganisms decays biological substances existing in water. They absorb oxygen solvated in water. The amount of oxygen that water can grasp in the solution is restricted. Solvated oxygen (DO) can spread an absorption up to

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10 ppm (parts per million) in cold water. However, oxygen in air is about 200,000 ppm. That's the cause why a reasonable quantity of biological substance when decays in water can reduce the water of its solvated oxygen. The absorption of solvated oxygen in water is extremely significant for marine life-forms. If the absorption of solvated oxygen of water is lower than 6 ppm, the development of aquatic animals gets subdued. Oxygen spreads into the water either by the means of atmosphere or from the procedure of photosynthesis executed by several marine floras in the sunlight. But in the dark, photosynthesis halts, nonetheless the plants actively breathe, causing decrease of solvated oxygen. The solvated oxygen, too, is consumed by bacteria to oxidize biological substances.

In case a lot of biological substance is out into water, the entire accessible oxygen is consumed. This results in death of marine life-forms that are dependent on oxygen. Therefore, anaerobiotic microorganisms (that do not need oxygen) start breaking down the biological waste and form toxins which have an unpleasant odor and are also hazardous to the health of human beings. Aerobic (oxygen needful) microorganisms damage these biological wastes and retain the water exhausted in solvated oxygen.

Therefore, the quantity of oxygen essential for microorganisms to break down the biological substance existing in a specific capacity of a sample of water is termed as **Biochemical Oxygen Demand** (BOD). The quantity of BOD in the water is a portion of the quantity of biological substance in the water, in terms of how much oxygen will be essential for it to break down organically. Pure water would have BOD value of less than 5 ppm. However, extremely contaminated water could have a BOD value of 17 ppm or even extra.

3. Chemical Pollutants: We are aware that water is a brilliant solvent. Water-soluble inert elements that comprise of hefty metals like cadmium, mercury, nickel, etc. create an imperative category of toxins. Wholly, these metals are hazardous to human beings as our bodies are unable to defecate them. Eventually, it goes beyond the acceptance parameters. These metals cause injuries to the kidneys, central nervous system, liver, etc. Acids (like sulphuric acid) obtained from mine drainage and salts from several varied sources consisting of raw salt which melts the snow and ice in the cooler weathers (sodium and calcium chloride) are water-soluble chemical toxins.

The biological chemicals are one more cluster of elements that originate in contaminated water. Petroleum goods contaminate numerous water bodies, e.g., major oil spills in oceans. Other biological materials with severe effects are the insecticides that move down from sprays or overflow from lands. Several manufacturing chemicals such as polychlorinated biphenyls (PCBs) that are utilized as cleansing solvent, detergents and manures increase the list of water contaminants. PCBs are supposed to be cancer-causing. These days maximum cleansers available are ecological. Nevertheless, their utilization can generate additional complications. The microorganisms accountable for decaying ecological cleanser feed on it and rise speedily. While rising, they might utilize all the oxygen solvated in water. The absence of oxygen slays more additional flora and fauna creatures of marine life. Manures comprise of phosphates as extracts. The accumulation of phosphates in water increases algae development. Such abundant development of algae coats the water exterior and decreases the oxygen concentration in water. This causes anaerobiotic circumstances, usually with buildup of obnoxious deterioration and deceased animal life. Therefore, bloom-infested water prevents the development of additional alive creatures in the water bodies. This procedure where nutrient enhanced water bodies hold up a thick vegetal population, which slays fauna life forms by decreasing its oxygen and causes a successive damage of biodiversity is known as **Eutrophication**.

Notes

Effects of Water Pollution and Standards

The International Standards for Drinking Water are given below and they must be followed.

Fluoride: For drinking purposes, water should be tested for fluoride ion concentration. Its shortage in drinking water is damaging to humans and results in illnesses like tooth decay, etc. Soluble fluoride is frequently put into drinking water to level up its concentration till 1 ppm or mg dm^{-3}. The F ions build the enamel on teeth a lot firmer by changing hydroxyapatite [$3(Ca_3(PO_4)_2.Ca(OH)_2$], the enamel on the exterior of the teeth into a lot firmer fluorapatite [$3(Ca_3(PO_4)_2.CaF_2$].

Although, F ion concentration above 2 ppm results in brown spots on teeth. Simultaneously, additional fluoride (over 10 ppm) results in an outcome that is damaging to bones and teeth, as described from some parts of Rajasthan.

Lead: Drinking water gets polluted with lead when lead pipes are implemented for transport of water. The prescribed upper limit concentration of lead in drinking water is about 50 ppb. Lead can harm kidneys, liver, reproductive system, etc.

Sulphate: Extreme sulphate (>500 ppm) in drinking water results in laxative outcome. If not, at reasonable levels, it does not cause any harm.

Nitrate: The extreme limit of nitrate in drinking water is 50 ppm. Surplus nitrate in drinking water can result in sicknesses like methemoglobinemia ('blue baby' syndrome).

Other Metals: The extreme concentration of some common metals suggested in drinking water are specified in Table 4.2(A).

Table 4.2(A): Parameters for Water Quality Characterization and Standards Domestic Water Supplies (in ppm)

Parameters	USPH Standard (1969)	ISI Standard (IS-2296-1963)
Physical Parameters		
Color	Colorless	–
Odor	Odorless	–
Taste	Tasteless	–
pH	6.0-8.5	6.0-9.0
Specific Conductance	300u mho cm^{-1}	–
Dissolved Oxygen (DO)	4 to 6 ppm	3.0 ppm
Total Dissolved Solids	500	–
Suspended Solids	5.0	–
Inorganic Substance		
Chlorides	250	600
Sulphate	250	1000
Cyanide	0.05	0.01
Fluoride	1.5	3.0
Nitrate + Nitrite	<10	–
Phosphate	0.1	–
Sulphide	0.1 mg^{L-1} (ppb)	–
Boron	1.0	–

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Calcium	100	–
Magnesium	30	–
Ammonia	0.5	–
Arsenic	0.05	0.2
Barium	1.0	–
Cadmium	0.01	–
Copper	1.0	–
Chromium (VI)	0.05	0.05
Lead	<0.05	0.1
Iron (Filterable)	<0.3	–
Manganese (Filterable)	0.05	–
Mercury	0.001	–
Silver	0.05	–
Salenium	0.01	0.05
Uranium	5.0	–
Zinc	5.5	–
Chromium	5.05	–
Nitrate	6.3	–
Organics		
COD	4.0	–

Table 4.2(B): Tolerance Limits for Trace Metals in Drinking Water

Element	Tolerance Limit (in ppm)	Element	Tolerance Limit (in ppm)
Al	1.0	Be	0.50
B	0.75	As	0.100
Cd	0.001	Cr	5.0
Co	0.2	Cu	0.2
Pb	5.0	Li	5.0
Mn	2.0	Mo	0.005
Mi	0.5	Se	0.005
Zn	5.0	V	10.0
Fe	0.1	Sc	0.01

Table 4.3: International Standards for Drinking Water

IS: 10500-1991 **(IS: 2296-1963)**

Parameter	Maximum Permissible UPSH Standard	Level WHO Standard	Mg/L European Standard (ppm)
pH	6.0-8.5	6.5-9.2	6.5-85
Special Conductance	300	–	400

Notes

BOD	5.0	6.0	–
COD	4.0	10.0	5.0
Arsenic	0.05	0.05	–
Boron	1.0	–	–
Calcium	100	100	100
Cadmium	0.01	0.01	–
Chromium	0.05	0.05	–
Copper	1.0	1.5	–
Iron	0.3	1.0	–
Lead	0.05	0.1	–
Chloride	250	500	25
Cyanide	0.05	0.05	–
Mercury	0.001	0.001	–
Magnesium	30	150	–
Nitrate + Nitrite	10	45	–
PAH	0.002	0.2	0.002
Total Hardness (as $CaCO_3$)	–	–	–
Pesticide	0.005	–	0.005
E.Coli	100/100 ml	100/100 ml	–
Total Dissolved Solids	–	500	–

Soil Conservation

Unless the loss of soil is checked, it would amount to a great loss for mankind. Thus, man has made use of his ecological training in the preservation of this one of the most important resources.

Principles of Soil Conservation

The chief agents of soil erosion are water and wind. The actual art of soil conservation is based on certain basic principles, which include: (i) to protect soil from impact of raindrops, (ii) to slow down the water from concentrating and moving down the slope in a narrow path, (iii) to slow down the water movement when it flows along the slope, (iv) to encourage more water to enter the soil, (v) to increase the size of soil particle, (vi) to reduce in the wind velocity near the ground by growing vegetation cover, ridging the land, etc., and (vii) to grow the strips of stubble or other vegetation cover which might catch and hold the moving particles of soil.

Keeping in view the above-said principles, ecologists have devised several methods, given below, to prevent the loss of soil during its erosion.

Methods of Soil Conservation

The various methods may be broadly arranged into the following types:

1. Conservation achieved by the use of plant vegetation cover

… Biological Methods

(a) In areas with normal farming, where vegetation itself is used for soil protection

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… Agronomic Practices

(b) In areas with low and moderate rainfall, where normal farming is not practically possible

… Dry Farming

(c) In areas suitable for successful growth of grasses which are used as soil binders to check soil erosion

… Agrostological Methods

2. Conservation achieved by supplementing the biological methods so as to increase the time of concentration of water, to reduce the velocity of water, or afford protection against damage due to runoff

… Mechanical Methods

(a) Construction of small basins along the contours

… Basin Listing

(b) Construction of small basins along the slopes to intercept and divert the runoff water

… Contour Terracing

3. Conservation achieved by purely mechanical methods including construction

… Other Methods

(a) Formation or widening of gullies

… Gully Control

(b) Growing vegetation alongside, construction of drains stone pitching, etc.

… Stream Bank Protection

(c) Checking the velocity of wind by tree plantations (windbreaks)

… Afforestation

1. Biological Methods

These employ the use of plant or vegetation cover.

(i) Agromic Practices: Natural protection by growing vegetation in a manner that reduces soil loss. These are:

(a) Contour Farming: An oldest method useful in areas with low rainfall in the preparation of the field with alternate furrows and ridges. Ridges at the same level are known as 'contours'. The water is caught and held in furrows and stored, which reduces runoff and erosion. On slopes, however, this type of farming is coupled with terracing.

(b) Mulching: It is effective against wind as well as water erosion. Some such plants as maize stalks, cotton stalks, tobacco talks, potato tops, etc. are used as a **mulch** (a protective layer formed by the stubble, i.e., the basal parts of herbaceous plants, especially cereals attached to the soil after harvest). Mulches (2-3" thick) reduce soil moisture evaporation and increase amount of soil moisture by addition of organic matter to soil.

(c) Crop Rotation: It decreases soil loss and preserves the productivity of land. The same crop year after depletes the soil mineral. This is overcome by cultivating legumes. A typical rotation consists of one year of fallow, followed by winter heat.

(d) Strip Cropping: It involves the planting of crop in rows or strips to check flow of water. It may be contour strip cropping (strips planted along the

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contour at 90° to the direction of slope), field strip cropping (strip planted parallel to each other), or wind strip cropping (strip planted in straight) parallel rows at 90° to the direction of prevailing wind).

(ii) Dry Farming: This practice is useful for croplands grown in low and moderate rainfall areas, where ordinary farming is at risk. Crop production, animal husbandry and growing grazing fields are the possibilities of checking erosion. Methods employed differ in different areas. Some of them are fallowing the land, strip cropping crop rotation, contour farming, etc.

(iii) Agrostological Methods: Grasses such as *Cynodon dactylon* are utilized as erosion-resisting plants. They are grown in strips between the crops. They act as stabilizers when grown in gully and sodding. Such methods include:

(a) Lay Farming: This aims to grow grasses in rotation with the field crops, which helps in building up the structure of soil, preventing soil erosion and improving its fertility.

(b) Retiring Lands and Grass: This aims to grow grasses on such lands where major proportion of the top soil has been eroded. Generally, grasses are allowed to grazing under suitable climate conditions.

2. Mechanical Methods

These methods are used as supplements to biological methods. These are as follows:

(i) Basin Listing: To construct small basin along the contours to retain water which also reduces its velocity.

(ii) Contour Terracing: To construct a channel along the slope to intercept and divert the runoff water. This may be:

(a) Channel Terrace: To dig channels at suitable intervals and the excavated soil deposited as a wide, low ridge along the lower edge of the channel.

(b) Broad-based Ridge Terrace: To construct ridge along both sides of the channel.

(c) Bench Terrace: To construct a number of platforms along contours or suitable graded lines across the slope.

3. Other Methods

These include the following:

(i) Gully Control: To check the formation or widening of gullies by constructing bunds, dams, drains or diversions through which excess runoff water is channelled.

(ii) Stream Bank Protection: To grow vegetation alongside the river bank, to construct drains, concrete or stone pitching, etc. for checking the cutting and caving of river banks.

(iii) Afforestation: Trees as windbreaks are planted in deserts which check the velocity of wind. Windbreaks are planted across the area at 90° to the prevailing wind. They check the spread of sand dunes or desert conditions or blowing away of the fertile top soil. Windbreaks may be planted in several rows. Afforestation is applied to Indian deserts, where such plants as *Lowsonia alba, Agave americana, Thevetia nerifolia, Colotropis gigantea, Ricinus communis, Zizyphus jujuba, Acacia catechu, A. nilotica, Cassia,*

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Dalbergia sissoo, Mangifera indica and *Tamarindus indica* serve as useful windbreaks.

Unfortunately, so far, very little effective work has been done in India to combat wind and water erosion. It is estimated that a programme for the control of wind erosion covering 50 million hectares would cost about 3,000 crores of rupees. This is assuming an average cost of not more than ₹ 600 per hectare to carry out necessary afforestation, grassing and protective measures. So far, roughly about ₹ 300 crores have been spent on soil conservation since the beginning of the plan more than 20 years ago.

Land use in India

According to the report of the International Geosphere Biosphere Programme (IGBP) submitted during 1995, changes in patterns of soil and land use influence the environmental conditions of any area. The changes in terrestrial or land covers of the earth bring about significant changes in several biophysical processes which in turn affect the global environment. Different patterns of land use of the land cover and the biophysical variables associated with each pattern are shown in Fig. 4.6. Changes in land cover include changes in biodiversity, primary productivity, soil quality, and runoff and sedimentation rates. Land covers and changes in them are sources and sinks for most of the matter and energy flows that sustain the whole biosphere and geosphere.

Land cover changes are mostly caused by man. Land use involves both the manner in which the biophysical variables of the land are manipulated and the intent underlying that manipulation, the purpose for which the land is used. Forestry, parks, livestock herding, suburbia and farmlands are for example the various purposes.

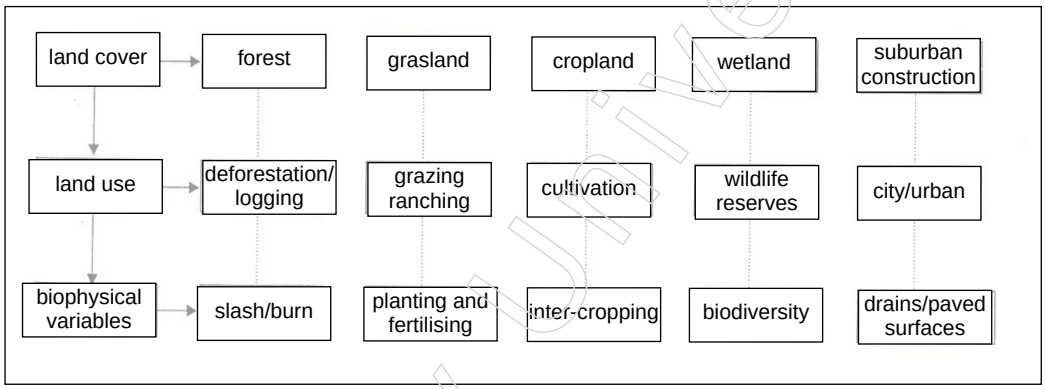

Fig. 4.6: Phases of Land use and Land Cover

Activity 2

You can visit local water bodies and witness, if the river/lake/tank/pond are pure/somewhat contaminated/moderately contaminated or extremely contaminated by observing water or by examining pH of water. Keep a report of the name of the river and the neighboring city or manufacturing units from where the contamination is produced. Notify about this to Pollution Control Board's Office set up by Government to measure contamination levels. Confirm that apt action is taken. You can write to the press also. Do not dump waste into a household or industrial drain which can arrive straight to any water body, like, river, pond, stream or lake. Utilize manure in the place of toxic composts in parks. Evade the utilization of insecticides like DDT, malathion, etc. at home and make an effort to utilize dehydrated neem leaves to benefit in keeping away pests. Put in some crystals of potassium permanganate ($KMnO_4$) or peroxiding powder to the water tank of your house.

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4.9 Soil Pollution and Soil Conservation

India, being based on agricultural economy, gives immense importance to farming, fisheries and cattle growth. The excess production is stockpiled by administrative and non-administrative governments for the scarcity period. The food damage at the time of storing, too, requires distinct consideration. Have you ever seen the harm caused to the crops, food items by pests, rodents, weeds and crop diseases, etc.? How can we shield them? You are familiar with a few pesticides and insect killers for shielding of our crops. Still, these pesticides and herbicides result in soil contamination. Thus, it is essential to make their sensible utilization.

Pesticides

Before the World War II, several organically originating toxins like nicotine (by farming of tobacco plants in the crop field) were utilized as insects preventing ingredient for prime crops in farming practices.

At the time of World War II, DDT was originated for excessive utilization in the prevention of malaria and additional insect-borne illness. Thus, post war, DDT was used in farming to regulate the destructions caused by pests, rodents, weeds and several harvest ailments. Still, because of opposing impacts, its utilization is barred in India.

Insecticides are fundamentally artificial poisonous substances with environmental consequences. The frequent utilization of similar insecticides increases the growth of pests that are unaffected to that category of insect killers, thus resulting in the ineffectiveness of the insecticides. Thus, as insect resistance of DDT amplified, additional biological pollutants like Aldrin and Dieldrin were presented in the market by insecticide industry. Maximum of the biological pollutants are water insoluble and non-biodegradable. These extreme determined pollutants are, thus, transported from lower trophic level to higher trophic level by the way of food chain. Eventually, the concentration of pollutants in developed faunas spread at a stage which results in severe metabolic and physical sicknesses.

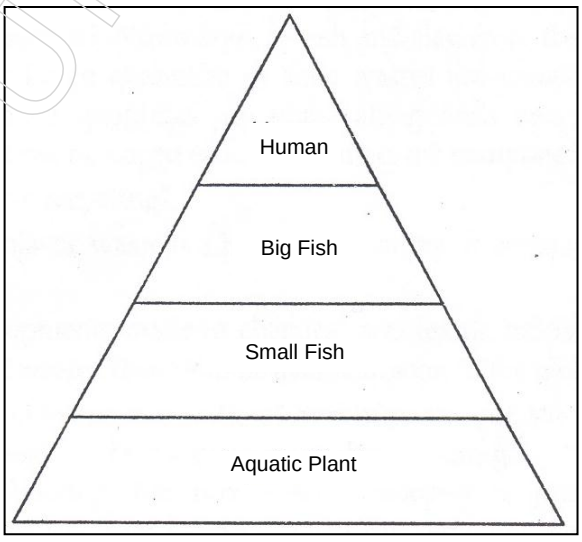

Fig. 4.7: Trophic Levels

In answer to extreme perseverance of chlorinated biological pollutants, a fresh sequence of low determined or high bio-degradable goods termed as organo-phosphates and carbamates are presented in the market. But these toxins are

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dangerous nervous system venoms and are proven most hazardous to human beings. As an outcome, there is information of a few insecticide-connected diseases of farming field labors. Pests have developed resilient to these pesticides too. The pesticide industry is involved in emerging new collections of pesticides. But one has to think, is this the solitary key to insect threat?

Nowadays, the insecticide manufacturing has lifted its consideration to **herbicides** like sodium chlorate ($NaClO_3$), sodium arsenite (Na_3AsO_3) and several more. At the time of the primary half of the previous century, the move from motorized to biochemical weed regulator had offered the business with prosperous financial market. But it is essential to reminisce that these are not eco-friendly.

Maximum weedkillers are poisonous to mammals, but are not as determined as organo-chlorides. These substances decay in some months. Like organo-chlorides, these too turn out to be concentrated in the food web. A few weedkillers result in genetic flaws. Studies demonstrate that cornfields sprayed with herbicides are most likely to get attacked by insects and vegetal ailments than fields that are weeded manually.

Insecticides and weedkillers signify a minor percentage of extensive biochemical contamination. A great amount of additional mixtures that are utilized frequently in biochemical and manufacturing procedures for industrial events are ultimately emitted in the environment in a single form or additional other forms.

4.10 Noise Pollution

We hear several kinds of noises every day. Sound is machine-driven energy from a vibrating source. A kind of sound may be enjoyable to somebody and the same can be disagreeable to other people. The disagreeable and annoying sound is termed as noise.

Sound can spread through a medium like air, liquid or solid. Sound wave is a compression perturbation in the medium through which sound travels. Sound pressure consecutively reasons in compression and rarefaction. The amount of compressions and rarefactions of the molecules of the medium (e.g., air) in a unit time is defined as frequency. It is stated in Hertz (Hz) and is equivalent to the number of cycles per second.

There is an extensive variety of sound pressures, which come across human ear. Rise in sound pressure does not appeal linear response of human ear. An expressive logarithmic scale has been created. The noise capacities are stated as Sound Pressure Level (SPL) which is logarithmic ratio of the sound pressure to a reference pressure. It is stated as a dimensionless unit, decibel (dB). The international reference pressure of 2×10^{-5} Pa is the average threshold of hearing for a healthy ear. Decibel scale is a measure of loudness. Noise can disturb human ear because of its volume and frequency (pitch).

The Central Pollution Control Board (CPCB) Committee has recommended permissible noise levels for different locations as given in Table 4.4.

Table 4.4: Noise Standards Recommended by CPCB Committee

Area Code	Category of Area	Noise Level in dB (A) Leq	
		Day	Night
(A)	Industrial	75	70
(B)	Commercial	65	55
(C)	Residential	55	45
(D)	Silence Zone	50	40

Notes

Table 4.5: Different Sounds and their Sound Levels on Decibel Scale

Sound Level (dB)		Source of Sound
	180 –	Rocket engine
	170	
	160	
	150 –	Jet plane take-off
Threshold of Pain	140	
	130	Maximum recorded rock music
	120 –	Thunder cap
	110 –	Auto horn 1 m away
	100	Jet fly over at 300 m, construction work, Newspaper press
	90 –	Motor cycle/8 m away, food blender
	80	
	70 –	Vacuum cleaner, ordinary conversation
	60 –	Air conditioning unit, 6 m away, light traffic noise, 30 m away
	50 –	Average living room
	40	
	30	Library, soft whisper
	20	Broadcasting studio
Threshold of Hearing	10	Rustling leaf
	0	

Sources of Noise Pollution: The foremost causes of noise are several means of transport (like air, road, rail-transportation), manufacturing actions, structure events and partying (communal/spiritual functions, elections, etc.) electronic home appliances.

High levels of noise have been noted in few of the metropolises globally. In Nanjing (China), noise level of 105 dB has been documented, whereas few additional metropolises globally have these levels: Rome (90 dB), New York (88 dB), Calcutta (85 dB), Mumbai (82 dB), Delhi (80 dB) and Kathmandu (75 dB).

Effects of Noise: Noise reasons in the subsequent effects:

(a) Interferes with Man's Communication: In a loud zone, communication is extremely poor.

(b) Hearing Damage: Noise can reason in time being or everlasting hearing damage. It is dependent on strength and duration of sound level. Hearing sensitivity is lessened with noise level of over 90 dB in the midnight frequency for added more minutes.

(c) Physiological and Psychological Changes: Constant contact to noise disturbs the operational activities of several structures of the body. It may cause high blood pressure, insomnia (sleeplessness), intestinal and digestive

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ailments, intestinal boils, blood pressure variations, behavioral fluctuations, emotional variations, etc.

Noise Pollution during Diwali

Diwali is known as the festival of lights. By tradition, all individuals of multiple age groups have fun bursting crackers. Few mishaps also happen each year resulting in some deaths. In addition, noise produced by several fireworks is not permitted, which goes beyond the levels of 125 decibels as per the Environmental (Protection) (Second Amendment) Rules, 1999.

This issue is of immense worry, the noise levels caused at the time of Diwali are very extreme. Few precautions taken by some particular scientists have been started at several locations at the time of Diwali. It is suggested that the producers of firecrackers must state the noise levels in decibels created by specific objects. The Division of Explosives of the Union Ministry of Commerce and Industry is trusted with the job to safeguard that the manufacturers make fireworks in compliance to the permitted noise standards.

As per to a current examination statement on fireworks made by the National Physical Laboratory, New Delhi, maximum fireworks existing in the market make noise beyond the permitted levels of 125 decibels as per the Environment (Protection) (Second Amendment) Rules, 1999. Few amongst them have been detected to make noise close to the verge of discomfort. The details are given in Table 4.6.

Table 4.6: Noise Levels Made by Fireworks

Type of Firecracker	Manufacturer	Generated Noise Level in Decibels
Atom bomb (timing bomb)	Coronation Fireworks, Sivakasi	135 ± 2
Chinese crackers (a string of 1,000 in one piece)	Sri Kaliswari Fireworks, Sivakasi	128
Chinese crackers (a string of 600 in one piece)	Sri Kaliswari Fireworks, Sivakasi	132
Nazi (atom bomb)	Coronation Fireworks, Sivakasi	135 ± 0
Magic formula (flower bomb)	Rajan Fireworks, Sivakasi	136 ± 1
Atom bomb (foiled)	Sri Kaliswari Fireworks, Sivakasi	131 ± 2
Hydrogen bomb	Sri Patrakali Fireworks, Sivakasi	134 ± 2
Rajan classic dhamaka (foiled bomb)	Rajan Fireworks, Sivakasi	136 ± 0
Samrat classic bomb (deluxe)	Venkateswara Fireworks, Sivakasi	136 ± 0
Hydro foiled (bomb)	Sri Kaliswari Fireworks, Sivakasi	132 ± 2
*Three sound (bomb)	Coronation Fireworks, Sivakasi	119 ± 7
Atom bomb	Local	136 ± 0

**Cracker meeting the noise pollution standards.*

The sound standards were observed under average circumstances, i.e., in zones which do not have sound reflecting exteriors within a 15 metre radius. Two devices for counting noise standards were fitted at a height of 1.3 metres and at a distance of 4 metres from the origin of noise.

Besides mentioning the sound levels on each of the types of firecrackers or banning the production of such firecrackers which produce noise above permissible levels, it is imperative to educate people about the harmful effects of noise during such

Notes

festivals like Diwali. It is very likely to be completed by giving public notices in the leading newspapers and messages through other mass media like radio and television.

Honorable Supreme Court in a Writ Petition (Civil) of 1998 concerning noise pollution had passed the following directions as an interim measure.

The Union Government, The Union Territories as well as all the State Governments in specific must obey the revised Rule 89 of the Environmental (Protection) Rules, 1986 enclosed under the Environmental (Protection) Act, 1986 which basically recites as follows:

1. The production, sale or utilization of fireworks making noise level exceeding 125 dB or 145 dB at 4 metres distance from the source of bursting must be forbidden.
2. For separate firework creating the series (linked fireworks), the aforementioned limit be decreased by 5 log 10 (N) dB, where N = number of fireworks linked collectively.
3. The utilization of firecrackers must be forbidden excluding from 6:00 PM. and 10:00 PM. Not any firecrackers must be lit from 10:00 PM. and 6:00 AM.
4. Fireworks must not be lit during any time in silence zones, as stated by the Ministry of Environment and Forests.
5. Silence Zone has been defined as "Silence Zone is a part including not less than 100 metres nearby hospitals, educational organizations, courts, religious places or any other zone which is stated as such by the capable authority".
6. The State Education Resource Centres in all the States and Union Territories as well as the management/principals of schools in all the States and Union Territories must undertake suitable measures teach school children regarding the harmful impacts of air and noise contamination and explain them of directions (1) to (3) above.

Control of Noise Pollution:

1. **Decrease in Causes of Noise:** Origins of noise contamination like hefty automobiles and old automobiles must not be permitted to work in the inhabited zones.
2. **Noise-creating Machineries** must be reserved in containers with sound soaking media. The noise pathway will be broken up and shall not spread where the staff works.
3. **Right Lubricating** will decrease the noise from the equipment.
4. **Use of Noise-soaking Silencers:** Silencers can decrease noise by soaking noise. For this reason, several kinds of fibrous substances can be utilized.
5. **Afforestation of Trees** which have wide leaves.
6. **Through law:** Legislature must safeguard that noise creation is lessened at numerous societal functions. Needless honking must be limited particularly in automobile jammed zones.

4.11 Thermal Pollution

Thermal contamination is explained as existence of waste heat in the water which can reason in unwanted variations in the natural ecosystem.

Reasons of Thermal Contamination: Heat-making businesses, i.e., thermal power plants, nuclear power plants, refineries, steel mills, etc. are the prime origins of thermal effluence. Power plants utilize only 1/3rd of the energy offered by remnant fuels for their processes. Residual 2/3rd is usually gone in the form of heat to the water

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utilized for cooling. Cold water usually is drawn from a few neighboring water bodies, passed through the plant and given back to the same water bodies, with temperature 10-16°C higher than the original temperature. Surplus of heat approaching these water bodies reasons in thermal contamination of water.

Effects of Thermal Pollution:

1. The solvated oxygen capacity of water is reduced as the solubility of oxygen in water is reduced at high temperature.
2. High temperature becomes a hurdle for oxygen penetration into deep cold waters.
3. Harmfulness of insecticides, cleansers and biochemicals in the wastes rises with upsurge in temperature.
4. The structure of plants and animals varies due to the sensitivity of breeds to amplified temperature because of thermal shock will be swapped by temperature accepting breeds.
5. Metabolic actions of marine life-forms upsurge at high temperature and need additional oxygen. However, oxygen level drops under thermal contamination.
6. Release of heated water close to the seashores can interrupt the reproduction and kill young fishes too.
7. Fish relocation is disturbed because of creation of several thermal areas.

Control of Thermal Pollution: The subsequent tactics must be implemented for regulation of thermal contamination:

(a) Cooling ponds

(b) Spray ponds

(c) Cooling tower

(a) Cooling Ponds: Water from condensers is deposited in ponds where natural evaporation cools the water which can then be recirculated or released in close by water bodies.

(b) Spray Ponds: The water from condensers is collected in spray ponds. Here, the water is sprayed through nozzles where fine droplets are formed. Heat from these fine droplets is degenerated into the environment.

(c) Cooling Towers:

(i) Wet Cooling Tower: Hot water is sprayed over baffles. Cool air coming from sides vanishes the heat and cools off the water. This cool water can be reprocessed or released. Big quantity of water is gone through evaporation, and in the locality of wet cooling tower, wide-ranging haze is created which is bad for the atmosphere and results in harm to plants.

(ii) Dry Cooling Tower: The heated water flows in a system of pipes. Air is passed over these hot pipes with fans. There is zero water loss in this technique, but fitting and process charge of dry cooling tower is a lot extra compared to wet cooling tower.

4.12 Marine Pollution

The prime origins of aquatic contamination are: (i) rivers that transport contaminants from their drainage sinks, (ii) catchment area, i.e., shoreline where humans reside and earn through hotels, manufacturing and farming practices, and (iii) oil drilling and shipment.

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Most of the rivers finally connect the ocean. The contaminants which these rivers transport from their drainage sinks are ultimately discharged into the sea. These consist of dirt, mud, manufacturing sewages, artificial cleansers, agrochemicals, hard waste substances, plastics, metallic element and waste heat emitted by businesses as conversed previously.

In the sea, the contaminants dilute and the biological substance is additionally broken down as in river water. However, several contaminants, particularly the intractable ones, stay unaffected or are partly decompose resulting in aquatic contamination. These contaminants become biomagnified, and disturb fisheries and several different aquatic life-forms. One more imperative origin of aquatic contamination is the drippy poisonous elements, radioactive wastes, etc. that are stockpiled in huge vessels and discarded in deep sea as it is seen as a better discarding location compared to land.

Tankers and other shipping means industries (petroleum, refinery, lubricating oil using industry, metal industry, paint industry, etc.), automotive wastes, refineries, ship accidents and offshore production add to marine pollution. Tankers transporting oil contribute to oil pollution significantly. After delivering the oil through sea route, earlier empty tankers used to be filled with water called ballast water to maintain balance. The ballast water comprising of remaining oil from trucks was discharged into the sea during the return voyage. At the present time, the oil floating on the ballast water is detached in the recently structured 'load-on-top-tankers' before ballast water is let off.

Oil in sea water can reach over a huge extent of the sea, stay outspread or get soaked on residues. It can reason in opposing impacts aquatic life-forms.

Oil in the sea water disturbs delicate plants and animals. Phytoplankton, zooplankton, algal breeds, several breeds of invertebrates, coral reefs, fish, birds and mammals are harmed by oil contamination. Fishes demonstrate mortality (death) because the fish gills get loaded with oil after the slimy mucus of gills is damaged. Oil disturbs the protecting abilities of feathers. Morality takes place because of failure to resist and consequent sinking of birds. Outflow from oil truck near Alaska in 1989 triggered harm to coral reefs and caused morality of approximately 390 thousand birds. Few significant events of bird death because of oil have been stated at Brittany, France where 20 thousand birds passed away because of more than 220 tons of oil spillage in 1978. At Elbe, Germany 500 thousand birds passed away in 1955. During the 1991 Gulf War, 200 million gallons of oil spread in the Persian Gulf severely damaged the aquatic environment.

Control of Marine Pollution:

(a) Poisonous contaminants from manufacturers and sewage treatment plants should not be released in seaside waters.

(b) Overflow from non-point bases should be prohibited to spread over seaside zones.

(c) Drain runoffs should be prohibited by making a distinct drain and rainwater pipes.

(d) Discarding of lethal, harmful waste and dirt mud must be barred.

(e) Developing events on seaside zones must be lessened.

(f) Oil and grease from service stations must be treated for recycle.

(g) Oil ballast must not be discarded into sea.

(h) Environmentally delicate seaside zones must be preserved by prohibited drilling.

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4.13 Nuclear Hazards

Radioactive elements are existing in nature. They experience natural radioactive deterioration in which unbalanced elements impulsively give out rapid moving elements, high energy radiations or both at a fixed rate until a fresh steady element is created.

The elements discharge energy either in the form of gamma rays (high energy electromagnetic radiation) or ionization particles, i.e., alpha particles and beta particles. The alpha particles are fast moving positively charged particles whereas beta particles are high speed negatively charged electrons. These ionization radiations have variable penetration power, as shown in the following diagram.

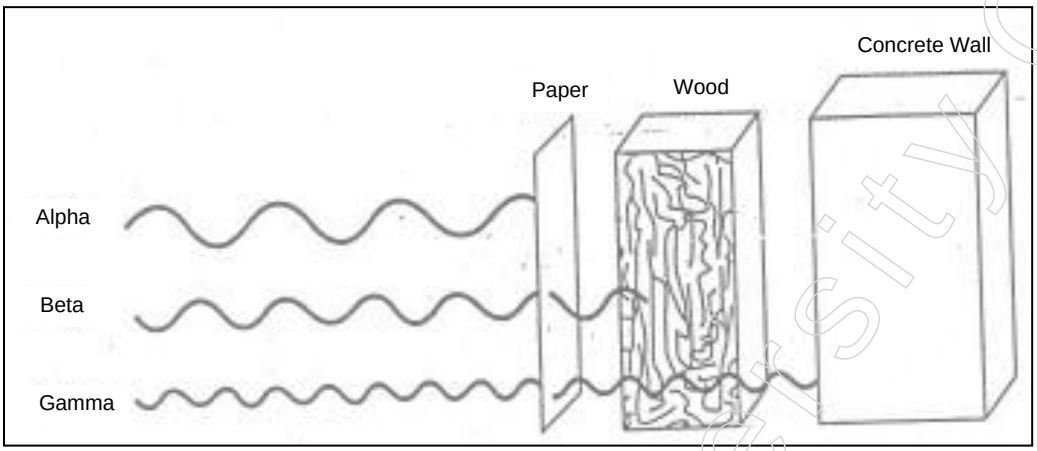

Fig. 4.8: Variable Penetration Power of Ionization Radiations Emitted by Radioisotopes

Alpha particles can be interrupted by a sheet of paper while beta particles can be blocked by a piece of wood or a few millimeters of aluminium sheet. The gamma rays can pass through paper and wood, but can be stopped by concrete wall, lead slabs or water.

Sources of Radioactivity

Various sources of radioactivity can be grouped into: (i) Natural sources and (ii) Anthropogenic (man-made) sources.

(a) Natural Sources: Sources of natural radioactivity include intergalactic energies from external planetary, radioactive radon-222, soil, rocks, air, water and food, which hold one or additional radioactive materials.

(b) Anthropogenic Sources: These bases are nuclear power plants, nuclear accidents, X-rays, diagnostic kits, test laboratories, etc. where radioactive materials are utilized.

Effects of Radiations

Ionization energies can disturb existing creatures by triggering damaging variations in the body cells and also fluctuations at heritable stage.

(a) Genetic Damage: It is instigated by energies that persuade alterations in the DNA, thus distressing genes and chromosomes. The injury is frequently perceived in off-springs and might be spread to numerous generations.

(b) Somatic Damage: It consists of blisters, miscarriages, eye cataract and cancer of bone, thyroid, breast, lungs and skin cancers.

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Several experts have an opinion that because of the body's capability to restore few of the injuries, the opposing impacts of energies are detected only beyond a threshold level. Still, the other group trusts that even a minor amount of energies over a period of time might reason in opposing impacts. They trust that the permitted limits of ionizing energies must be additionally decreased.

Harm triggered by various kinds of energies is dependent on the diffusion power and the existence of the basis inside or outside the body. Alpha elements have absence of diffusion power, but they have additional energy than beta. They will be, thus, hazardous when they arrive in the body by breathing or by eatables. Alpha elements fail to enter the skin to spread over inner body parts. However, beta elements might harm the inner body parts. Bigger hazard is posed by radioisotopes with in-between half-lives as they have long time to discover the access inside the human body.

Radioisotopes arrive in the atmosphere at the time of mining of uranium. The particle emission on the earth's coating arrives in the crops grown there and eventually in human beings. Radionuclides arrive in the water bodies or the groundwater coming in connection with the polluted soil or rock.

Radioactive iodine (I^{131}) gathers in thyroid gland and reasons in cancer. Likewise, strontium-90 gathers in the bones and reasons in leukemia or cancer of bone marrow.

Control of Nuclear Pollution:

(a) Location of nuclear power plants must be sensibly completed after studying lasting and temporary impacts.

(b) Correct discarding of waste from laboratory linking the utilization of radioisotopes must be completed.

4.14 Solid Waste Management

Developed standards of living of ever-increasing population has caused an upsurge in the number and variability of pollutants produced. It is been realized that if waste materials production stays extensively, then shortly it would cross the levels of modification. Managing hard waste matter has, thus, become significant in direction to lessen the opposing impacts of hard waste substances. Hard waste matter (wastes apart from fluids or vaporous) can be categorized as municipal, manufacturing, farming, medicinal, mining waste and dirt mud.

Sources of Urban and Industrial Wastes

Urban Waste: City waste matter contains:

- Medicinal waste matter from hospitals; municipal hard waste substances from households, workplaces, marketplaces (commercial waste) small cottage units, and agriculture waste matter from gardens, woodlands, etc.
- Waste matter from households (domestic waste) comprises of a variability of castoff supplies such as polyethylene bags, empty metal and aluminium cans, scrap metals, glass bottles, waste paper, diapers, cloth/rags, food waste, etc.
- Waste matter from shops primarily contains waste paper, wrapping supplies, tins, bottles, polyethylene bags, peanut shells, eggshells, tea leaves, etc.
- Biomedical waste substances consist of functional waste materials, pathological waste materials, infectious waste materials, etc.
- Building/destruction waste materials consist of rubbles, wood, cement, etc.
- **Agriculture waste** materials **and waste** materials **from slaughter houses** consist of plant portions and remains of killed animals.

(c) Amity University Online

Notes

The city's hard waste materials which can be decayed by bacteria are termed as decomposable waste materials. Examples of this kind of waste materials are plant waste materials, decayed food tea leaves, egg-shells, peanut shells, dry leaves, etc. Waste materials that are failed to be decomposed by bacteria are termed as non-decomposable waste materials, e.g., polyethylene bags, scrap metal, glass bottles, etc.

Industrial Waste: Manufacturing waste materials contains a bulky quantity of constituents counting in workshop garbage, wrapping supplies, biological waste materials, acids, alkalis and metallic element, etc. At the time of a few manufacturing, processing big amounts of dangerous and poisonous elements too are created. The prime origin of manufacturing waste materials are biochemical manufacturers, metallic and mineral dealing businesses. Radioactive waste materials are produced by nuclear power plants. Thermal power plants create fly ash in big amounts. Hard waste materials from more kinds of businesses consist of scrap metal, gum, plastic, paper, glass, wood, oils, paints, asphalt, tars, dyes, scrap leather, ceramics, abrasives, slag, heavy metals, asbestos, batteries, etc. In Europe and North America, the ecological regulations and protection rules are becoming more severe because of which discarding of dangerous waste materials is now an issue. Price of discarding of these waste materials is growing. Thus, such waste materials are being carried across to evolving nations that do not have adequate information or system for its own discarding.

Effects of Solid Wastes

Civic hard waste materials pile up on the streets because of inappropriate discarding structure. Individuals clean their own houses and litter their immediate environments that disturb the public counting in themselves. Such kind of discarding permits decomposable constituents to decay under unrestrained and polluted circumstances. This creates a bad odor and strains several kinds of pests and transmittable creatures in addition to damaging the aesthetics of the location.

Industrial hard waste materials are bases of poisonous metallic elements and dangerous waste materials, that might grow on land and can reason in variations in physio-chemical and organic features in that way disturbing efficiency of soil. Poisonous elements might percolate to pollute the ground water.

If garbage consisting of the dangerous waste materials, are combined with trash and other flammable waste materials, thus, the separation becomes difficult. Several kinds of waste materials such as tins, insecticides, cleansing diluters, batteries (zinc, lead or mercury) radioactive constituents, plastics are combined with paper, scraps and many other non-poisonous resources which can be reprocessed. Burning of these resources create dioxins, furans and polychlorinated biphenyls that have the possibility to reason in several kinds of sicknesses counting in cancer.

Management of Solid Waste: For waste management, we stress on "3Rs" – Reduce, Reuse and Recycle before demolition and protected storing of waste materials.

(a) Reduction in Use of Raw Materials: Decrease in the utilization of raw materials will consistently reduce the making of waste materials. Decreased request for metal goods will reduce their mining and result in minor creation of waste materials.

(b) Reuse of Waste Materials: The reusable vessels that are castoff after utilization can be recycled. Villagers make cooking pots and grain storage from waste materials paper. Creating gum rings from the castoff bicycle tyres, that are utilized by the paper sellers, in the place of gum bands, decreases the waste materials production while making of gum bands. Due to monetary restrictions, underprivileged persons recycle their supplies to the maximum.

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(c) **Recycling of Materials:** Reprocessing is the procedure of castoff supplies into fresh beneficial goods.

(d) **Creation of Few Old Kinds of Goods:** For example, old aluminium cans and glass bottles are melted and recast into fresh cans and bottles.

(e) **Formation of New Products:** Preparation of cellulose insulation from paper, preparation of fuel pellets from kitchen waste, and preparation of vehicles and building supplies from steel cans.

The procedure of reducing, reusing and recycling saves money, energy, raw materials, land space and also decreases effluence. Reprocessing of paper will decrease chopping of trees for creating new paper. Recycle of metallic element will decrease mining and smelting of ores for retrieval of metallic element from ores and avert effluence.

For disposal of waste materials, the subsequent approaches can be implemented:

(a) **Sanitary Landfill:** In a sanitary landfill, trash is outspread in small coatings, compressed and enclosed with clay or plastic foam.

In the current landfills, the bottommost part is enclosed with a resistant lining, typically numerous coatings of clay, thick plastic and sand. The lining shields the ground water from being polluted because of filtration of leachate. Leachate from lowermost part is propelled and sent for treatment. When landfill is full, it is enclosed with clay, sand, gravel and top soil to avert leakage of water. Numerous wells are dug around the landfill location to monitor if any seepage is polluting ground water. Methane formed by anaerobiotic decay is gathered and burnt to make electrical energy or heat.

(b) **Composting:** Because of lack of space for landfill in superior metropolises, the decomposable yard waste materials (reserved distinct from the civic waste materials) is permitted to decay in an oxygen enrich medium. A good quality, nutrient-rich and eco-friendly compost is created that progresses the soil situations and fruitfulness.

(c) **Incineration:** Furnaces are burning plants capable of burning a huge quantity of resources at high temperature. The original price is expensive. At the time of incineration, high levels of dioxins, furans, lead and cadmium might be released with the fly ash of incinerator. Dioxin level may spread many times more than in the ambient environment. For incineration of constituents, it is better to remove batteries containing hefty metallic element and plastic comprising of chlorine before burning the material. Prior to the elimination of plastics, releases of dioxins and polychlorinated biphenyls (PCBs) will decrease.

4.15 Role of an Individual in Prevention of Pollution and Case Studies

The part of each person in avoiding effluence is of supreme importance because if each person contributes considerably, the result will be noticeable not only at the public, metropolitan, national level, but also at the international level as atmosphere has zero limitations. It is the duty of the human beings that have occupied the commanding position on this earth to defend the earth and offer favorable atmosphere for itself and countless more breeds which grew on this earth. A minor contribution made by everybody at their own place will have noticeable outcome at the international level. It is aptly said, "*Think globally, act locally".*

Notes

Everybody must alter their lifestyle to decrease ecological contamination. It can be attained by subsequent recommendations:

- Assist more in effluence stoppage than effluence regulation.
- Utilize environmentally friendly harvests.
- Minimize the utilization of chlorofluorocarbons (CFCs) as they terminate the ozone layer. Do not use polystyrene cups that have chlorofluorocarbon (CFC) molecules in them which destroy ozone layer.
- Utilize the compounds obtained from peaches and plums to clean computer chips and circuit boards instead of CFCs.
- Use no CFC fridge freezers.
- The production and process of appliances must be invigorated that do not contaminate. If they cost more, then their higher prices may be offset by including environmental and the social costs of pollution in the price of such products which pollute environment. Air contamination can be prohibited by means of pure fuel, i.e., hydrogen fuel. Hydrogen for that matter must not be formed by passing current in water for the production of current. Again, the atmosphere will be contaminated. So, solar-driven hydrogen fuel is the necessity of the hour.
- Decrease your dependence on remnant fuel particularly coal or oil.
- Save electrical energy by not wasting it when not in use because electricity saved is electricity produced without contaminating the atmosphere. Put on warm clothes rather than switching on a heater.
- Implement and promote renewable energy sources.
- Advance energy effectiveness. This will decrease the quantity of waste energy, i.e., more is attained with little energy.
- Encourage recycling anywhere probable and decrease the creation of waste materials.
- Utilize bulk transportation system. For small trips, make use of bicycle or go on foot. Reduce the utilization of vehicles.
- Use insecticides only when undeniably essential and that too in correct quantities. It is advisable to use insect management with biological control.
- Use rechargeable batteries. Rechargeable batteries will decrease metallic effluence.
- Use minor dangerous chemicals wherever their application can be afforded. Baking soda, vinegar and borax can help in cleaning, bleaching and softening. Baking soda can be an alternative for modern deodorants.
- The hard waste materials produced at the time of single industrial procedure can be utilized as a raw material for other procedures.
- Use little phosphate, phosphate-free or decomposable dish washing liquid, laundry detergent and shampoo. This will decrease eutrophication of water bodies.
- Utilize biological compost as an alternative for commercial inorganic manures.
- Do not put insecticides, tints, diluters, oils or other damaging chemicals into the sewer or ground water.
- Utilize just the least essential quantity of water for several activities. This will avert fresh water from contamination.
- When constructing a house, do not cut maximum trees in that zone.

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- Start afforestation. Trees can soak several poisonous fumes and cleanse the air by emitting oxygen.
- Check population growth so that demand of materials is under control.

Pollution – Case Studies

Air Pollution Episodes

A sequence of air contamination tragedies have taken place in the past 75 years from Meuse Valley, Belgium (1930) to Chernobyl Nuclear Disaster in the erstwhile **USSR (1986)**. Few significant ones are given below:

Donora Air Pollution Disaster: Donora or Pennsylvania (in USA) is airmail mill city subjugated by steel mill, zinc smelter and sulphuric acid plant, a 4-day haze took place from October 25-31, 1948. Because of anticyclonic climate circumstances, there was zero air movement and temperature upturn had set in due to sea breeze circumstances. Donora lies in a horse shoe shaped valley on the Monongahela river, South of Pittsburgh with sharp rising hills on both sides of the river.

Haze that was created because of buildup of cold air at the bottom-most part of the river valley persevered for four successive days. This state, when cold layer is stuck underneath the warm layer, is called inversion. The topmost haze coating reflected the solar radiations at the day time. So, the heat collected by it was inadequate to breakdown the day time. At night, the topmost coating had been losing heat which additionally cooled the coating to alleviate. Wind speed in the inversion coating was slow moving. The lethal toxins released by the steel mill, zinc smelter and sulphuric acid plant got stuck and concentrated in the steady climatic situations of the valley and stayed there for four days. About 6,000 of the town's 14,000 people fell sick and 20 of them died.

The Bhopal Gas Tragedy: The world's biggest manufacturing mishap took place in Bhopal, Madhya Pradesh, India on the night of December 2, 1984 and morning of December 3, 1984. It took place in the Union Carbide Company that manufactured Carbaryl (Carbamate) insecticide using Methyl Isocyanate (MIC). Due to the unintended entrance of water in the tank, the reaction combination got inflamed and blasted, and thereby its chilling arrangement turned futile. Additional protection appliances failed to function. 40 tons of MIC seeped into the environment and might have consisted of 40 kg of phosgene as a contamination. MIC fume at lesser concentrations disturbs lungs and eyes, and results in irritation of the skin. Larger quantities eliminate oxygen from the lungs and can result in demise. In the winter night of December, there were haze-like clouds over south and east of the plant. The gas outspread across 40 km^2 area. About 5,100 people were killed (2,600 because of straight contact to MIC and other 2,500 because of later impacts of contact). As per Indian officials, approximately 2,50,000 people got in contact with MIC. A projected 65,000 individuals ached from serious eye, breathing, neuromuscular, intestinal and pregnancy ailments. Approximately 1,000 people turned blind. Without counting the harm caused to human beings, it costed about $570 million in clear-out and harm settlement. This disaster might have been prevented had the business spent about $1 million on protection development.

The Love Canal Tragedy: The Love Canal disaster took place in a suburb of Niagara Falls, New York. The Love Canal was constructed by William Love which was later dug up to discard sealed steel drums of chemical waste substances by Hooker Chemicals and Plastics Corporation between 1942-1953. In 1953, the junkyard was enclosed with clay and top soil by the company, and was sold to the city Board of Education which constructed an elementary school on that location. Houses, too, were

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constructed nearby the school. In 1976, the inhabitants started complaining of bad odor. Kids playing in the waterway zone got chemical blisters.

In 1977, the rusted steel vessels began dripping the chemicals into storm drains, underground of homes and the school play area. Approximately, 26 poisonous biological mixtures were recognized. The junkyard was enclosed with clay and the dripping waste matter were propelled to a fresh treatment plant. The impacted families were moved.

There might be additional junkyards same as the Love Canal particularly in the third world countries. Who knows what expanse of damage these junkyard are triggering to the basement aquifers?

Arsenic Pollution in Groundwater: West Bengal and Bangladesh are seriously polluted by the lethal hefty metallic arsenic. The primary account of arsenic contamination in West Bengal came in 1978 and that in Bangladesh in 1993, where it was observed as even more extensive. Arsenic intoxication has broad penalties. The local people were found to be eating little dosages of arsenic for 10-14 years after which unexpectedly white or black spots called melanosis began streaking the skin. The spots were later changed into leprosy like skin lesions covering the palms and soles, eventually rotting into gangrenous ulcers. Extended contacts frequently led to bladder and lung cancer. Kids are severely impacted by arsenics, the impacted persons are communally remote, kids banned from going to schools and young women stayed single or had broken marriage. The WHO has arranged the maximum allowable limits of arsenic as 10 mg/L. In West Bengal, 40 million out of 90 million people are dreaded to come in contact with arsenic danger because of polluted water. The 24 Parganas, Hooghly and Murshidabad regions as also Behala and South Eastern fringes of Kolkata lie in Arsenic Risk Zone. Previously, it was assumed that the arsenic has arrived into groundwater because of geologic reasons in the Ganga Delta. Lately, however, it is being connected with anthropogenetic reasons.

Extreme utilization of lead arsenite and copper arsenite as insecticides in high yielding variabilities of summer paddy and jute crop appears to be the foremost reason of arsenic contamination. Now, the arsenic polluted tubewells in the state are being painted red while safe water tubewells are painted green for consumption by individuals.

Chernobyl Nuclear Disaster: Chernobyl nuclear disaster is the nastiest nuclear tragedy in the history of human evolution which took place in Chernobyl, Ukraine, previously USSR (now CIS). On April 26, 1986, the mishap took place in the device of the Chernobyl Power Plant intended to create 1000 MW electrical energy. The device had been operating uninterruptedly for 2 years. It was shut down on April 25, 1986 for midway maintenance. This period concurred with the period when individuals counting in the top managers were busy in the arrangements for nationwide day off, The May Day. Because of defective processes of shutting down the plant, a blast took place in the device at 01:23 hours on April 26, 1986. Three seconds later, one more blast took place. The blast was seriously damaging that the 1000 tons steel concrete lid of the device blew-off. Fire began at the device because of burning of graphite rods. The device temperature flew to more than 2000°C. Fuel and radioactive rubble emitted out in a volcanic cloud of melted mass of the *core* arid gases. The rubble and fumes floated over most of the northern hemisphere. Poland, Denmark, Sweden and Norway were badly impacted.

On first day of the mishap, 31 people died and 279 people were hospitalized. Since the cloud was rich in Iodine-131; Cesiuin-134 and Cesium-137, it was dreaded that some of the 5,76,000 people in contact with the radiations would suffer from cancer especially thyroid, cancer and leukemia. Kids were most prone as Iodine-131 is consumed primarily through milk and milk products.

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As kids drink more milk and their thyroid glands are in the growing stage, an upsurge in thyroid cancer in kids from zones nearby Chernobyl was recorded. More than 2000 people died. People suffered from ulcerating skin, loss of hair, nausea and anemia. Farming harvest was spoiled for years. Strong energies demolished numerous fields, trees, shrubs, plants, etc. Plants and animals were harmed. There are health issues like, Blood abnormalities, hemorrhagic sickness, changes in lung tissues, eye diseases like cateract etc were observed. The atomic energy is inexpensive, infinite and non-polluting source of energy. Still, without correct maintenance and carefulness, similar mishaps like Chernobyl can take place in the society.

Table 4.7: Cities with Maximum Pollution

Sr. No.	Name	State/UT
1	Bhadravati	Karnataka
2	Chembur	Maharashtra
3	Digboi	Assam
4	Dhanbad	Bihar
5	Durgapur	West Bengal
6	Govindgarh	Punjab
7	Greater Cochin	Kerala
8	Howrah	West Bengal
9	Jodhpur	Rajasthan
10	Kala-Amb	Himachal Pradesh
11	Korba	Madhya Pradesh
12	Manali	Tamil Nadu
13	Nagda-Ratlam	Madhya Pradesh
14	Najafgarh Drain Basin	Delhi
15	North Arcot	Tamil Nadu
16	Pali	Rajasthan
17	Parwanoo	Himachal Pradesh
18	Patancheru-Bollaram	Andhra Pradesh
19	Singrauli	Uttar Pradesh
20	Talcher	Orissa
21	Vapi	Gujarat
22	Vishakhapatnam	Andhra Pradesh
23	Tarapur	Maharashtra
24	Ankleshwar	Gujarat

4.16 Disaster Management

Geographical courses such as earthquakes, volcanoes, floods and landslides are usual natural events which have caused the creation of the earth that we have today. They are, however, devastating in their effects when they disturb human settlements. Human civilizations have observed a huge number of these natural dangers in various regions of the world and have tried to learn to regulate these procedures to some amount.

Earthquakes

Earthquakes arise because of unexpected moving of earth's crust. The earth's crust has numerous tectonic plates of hard rock which gradually move along their boundaries. When friction averts these plates from sliding, pressure builds up and causes unexpected breakages which can occur along the boundaries of the plates or fault lines (planes of weakness) within the plates. This results in earthquakes, the fierce, temporary vibrations in the earth. The point on a fault at which the initial movement arises at the time of an earthquake is termed as the epicenter.

The harshness of an earthquake is usually counted by its magnitude on Richter Scale, as shown below:

Table 4.8: Magnitude of Earthquake

Richter Scale	Severity of Earthquake
Less than 4	Insignificant
4-4.9	Minor
5-5.9	Damaging
6-6.9	Destructive
7-7.9	Major
More than 8	Great

The biggest earthquake ever documented arose on May 22, 1960 in Chile with the projected degree of 9.5 on Richter Scale, disturbing 90,000 square miles and killing 6,000 people.

The disturbing earthquake which hit Bhuj Town in Gujarat had triggered enormous harm, killing 20,000 to 30,000 people and leaving several wounded. It had an energy equivalent to a 5.3 megaton hydrogen bomb.

Earthquake produced water waves termed as tsunamis can harshly disturb seaside zones. These giant sea swells can move at a speed up to 1000 km/hr or even quicker. While approaching the seashore, they may often reach 15 m or sometimes up to 65 m height, and result in huge destruction in seaside zones. In China, these waves killed 8,30,000 people in 1556 and 50,000 in 1976.

Anthropogenetic actions, too, can reason in enhanced frequency of earthquakes. Three such events recognized are:

(a) Impounding of vast amounts of water in the lake behind a big dam.

(b) Basement atomic testing.

(c) Deep well disposal of liquid waste.

Harm to property and life can be averted by building earthquake-resilient structures in the earthquake susceptible regions or seismic zones. For this, the constructions are profoundly armored, weak spots are tactically located in the structure that can soak vibrations from the rest of the building, and pads or floats are located underneath the structure on which it can move harmlessly at the time of ground motion. Wooden houses are ideal in an earthquake prone area as in Japan Floods.

Floods

Usually, the river channels lodge in some maximum stream flow. Still, because of substantial rainfalls or unexpected snow melt, the amount of water in rivers surpasses their size and water run offs the banks, and results in floods on the neighboring land. This condition is termed as flood.

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A flood usually does not harm property or reason in causalities to a level as done by other natural tragedies. Nevertheless, it results in a excessive financial loss and health associated difficulties, because of extensive pollution. Practically whatever the flood water touches get polluted, posing severe danger to well-being because of outburst of epidemics.

Human actions have been the primary reason for growing the harshness and occurrence of floods. Building of infrastructures, car park spaces and structures that cover the earth's exterior barely permits penetration of water into the soil and speeds up the overflow. Chopping of woodlands for farming, too, has amplified the brutality of floods.

In India, Uttar Pradesh is considered to be amongst the worst flood hit states of the country. It has nearly 20% of the total 40 million hectares of flood-prone zone of the country.

Flood plains, the low-lying zones, which get flooded at the time of inundations, help to decrease overflows. Construction of overflow regulating structures such as flood walls or thickening of river channels have only moved the difficulties downstream. Constructing walls averts leaking out the flood water over flood plains, but it upsurges the speed of water to disturb the zones down the river with immense power.

Table 4.9 demonstrates the rate of natural dangers in our nation. On an average, each year, one major tragedy hits India, triggering vast financial losses and damage to humans. There is a necessity for orderly studies and policies to develop a Disaster Management Plan for our nation.

To check the floods, efforts are needed to be made to bring back marshes, swap ground cover on water courses, build check-dams on minor rivers, shift structures off the flood plains, etc. In the place of rising structures on flood plains, it is recommended that flood plains must be utilized for wildlife habitat, gardens, leisure zones and other uses, which are not prone to flood damage. River networking in the country is also being planned to handle flood problems.

Table 4.9: Disaster Management

Type	Location/Area	Affected Population (in Million)
Flood	8 major river valleys spread over 40 million hectares of area in the entire country	260
Drought	Spread in 14 states of Andhra Pradesh, Bihar, Gujarat, Haryana, Jammu & Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh, West Bengal and Himachal Pradesh covering a total of 116 districts and 740 blocks	86
Earthquake	Nearly 55% of the total area of the country falling in the seismic zone IV and V	400
Cyclones	Entire 5700 km long coastline of Southern, Peninsular India covering 9 States, viz., Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa and West Bengal and Union Territory of Pondicherry besides islands of Lakshadweep and Andaman and Nicobar	10
Landslide	Entire sub-Himalayan region and Western Ghats	10

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Landslides

Landslide arises when clear rock of soil masses shifts down slope because of gravitational pull. Slow moving landslides do not reason in much concern, but unexpected rockslides and mudslides is a matter of concern.

Water and plants effect landslides. Chemical action of water slowly results in chemical surviving of rocks making them likely to landslides. Plants combines the slant substances, offers consistency by its root system and also holds back the flow of water and its corrosion size.

Still, this can be disguised by several other applying issues such as:

(i) Earthquakes, vibrations, etc.

(ii) Disturbances in resistant rock overlying rock of low resistance.

(iii) Saturation of the unconsolidated sediments with water.

(iv) Unconsolidated sediments exposed due to logging, road or house building.

Landslides are governed by the forces which tend to pull the earth material down slope (move in case of slopes with steeper slip plane) and resisting forces which tend to resist such movements.

It is problematic to control landslides. Still, these can be diminished by steadying the slope by:

(i) Draining the surface and subsurface water.

(ii) Providing slope support like gabions (wired stone blocks).

(iii) Concrete support at the base of a slope.

Cyclones

Cyclones are recurrent phenomena in the humid seaside areas. Humid cyclones in the warm oceans are created due to heat and moisture. One of the necessities for creation of humid cyclones is that the sea's exterior temperature (SST) must be above 26°C. Humid cyclones move like a rotating top at the speed of 10-30 kms per hour. They can stay for a week or so and have a diameter changing between 100 to 1500 kms. Subsequently, in the western zones of the foremost ocean, zero cold currents occur and humid cyclones initiate there. Humid cyclones are termed as **'hurricanes'** in the Atlantic, Caribbean and North Eastern Pacific; '**typhoons'** in the western Pacific; **'cyclones'** in the Indian Ocean and **'willy willies'** in the sea around Australia.

Additional hurricanes arise in the Bay of Bengal than in the Arabian Sea. Out of the 5-6 hurricanes that form in the year, approximately half of them are damaging. Hurricane winds (74 miles per hour or more), rains and storm surge (often 50-100 miles wide dome of water) frequently distress the part where it attacks on land. The destruction is furthermore when hurricane flow and usual astral current concur. Sea water with mutual power rushes inlands and floods the low-lying parts.

Management: Its problematic to break the return of hurricanes. Few long-lasting protection steps can assist to defend us from destruction. These steps involve afforestation on the seaside areas, building of dams, dykes, ridges, hurricane shelter, wind breaks, appropriate drainage and wide roads for fast evacuation.

4.17 Summary

Ecological contamination is the result of unwanted variations in our environments and that has damaging impacts on floras, faunas and humans. Pollutants can be in different forms such as solids, liquids and gases. The global warming and enhanced

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greenhouse effect are the major issues due to the pollutants. Pollutants in soil that comes from pesticides and herbicides are highly toxic. Managing manufacturing hard waste materials is a huge problem and requires proper strategies and knowledge to control. Every individual, therefore, must change lifestyle so as to reduce pollution.

4.18 Check Your Progress

I. Multiple Choice Questions

1. Air pollution means _____.
   (a) The concentration of some harmful substances for humans and surroundings
   (b) The change in temperatures
   (c) The temperature which keeps going down
   (d) The cyclones
2. Which of the gases is produced due to incomplete combustion?
   (a) Oxygen
   (b) Ammonia
   (c) Helium
   (d) Carbon monoxide
3. Out of the given illnesses, which one spreads due to dust particles in the air?
   (a) Typhoid
   (b) Naru
   (c) Asthma
   (d) Yellow fever
4. From _____ intensity, sound pollution starts.
   (a) 200 decibels
   (b) 100 decibels
   (c) 75 decibels
   (d) 14 decibels
5. In 1986, due to the leakage from atomic reactor, many people lost their life at _____.
   (a) Chernobyl
   (b) Leningrad
   (c) Moscow
   (d) Vladivostok
6. _____% electricity is produced from nuclear energy in the world.
   (a) 50
   (b) 70
   (c) 3
   (d) 17

4.19 Questions and Exercises

1. Name various at atmospheric pollutants.
2. What are the adverse effects of air pollutants?
3. Describe in brief the sources, effects and control of noise pollution.

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4. Write short notes on:
   (a) Biomagnification
   (b) Minamata disease
   (c) Thermal pollution
5. Explain solid waste management.

4.20 Key Terms

- **Half-life:** Time required by a substance to decay by half.
- **Landslide:** Simultaneous moving of pebbles or mud on a downhill.
- **Mutation:** Sudden heritable change.
- **Pathogen:** Organisms that cause diseases.
- **Salinity:** Amount of soluble salts in water or soil.
- **Sludge:** Settled solids removed from waste water.

4.21 Check Your Progress: Answers

I. Multiple Choice Questions

Question	Answer
1	(a)
2	(d)
3	(c)
4	(c)
5	(a)
6	(d)

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Module IV: Social Issues and the Environment and Human Population and the Environment

Unit V: Social Issues and the Environment

Structure:

Objectives

After studying this unit, you should be able to:

- Understand sustainable development
- Recognise metropolitan issues linked to energy
- Know water conservation and rainwater harvesting
- Explain climate change, global warming and disaster management
- Describe environmental legislation, issues involved and public awareness

5.1 Introduction

What is Development?

The debate conducted with a small group yielded the following responses:

- Life is for living, singing songs, creating art, growing food, being with and taking care of family and friends, and also the village or town.

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- Development is a continuing procedure which is intended to bring about the welfare of all living beings.
- What, if in the course of refining the level of welfare of my family or community, some other family or community has to bear some loss – is that development?
- Development is becoming educated and civilized, and includes mental and moral development.
- Write up the different views emerging from your debate, on large chart paper and put these up in the classroom. Refer to these while studying this unit.

Growth traditionally intended economic well-being or wealth, and having conveniences and amenities. The well-being of an individual family, community or country depends on several factors apart from income levels or wealth. 'Development' is more than 'economic development'.

The Environment from Unsustainable to Sustainable Development

To 'sustain' means to continue'. That which cannot continue and stops is therefore 'unsustainable'.

A good way to understand sustainability is to first understand unsustainability. Here is a simplified example to understand 'unsustainability.'

USA was well-known for its production of oranges. Over time, the area under oranges increased and USA became the largest producer of oranges in the world. Production became so high that there was a glut of oranges. Then there came a time when oranges became very cheap. Nobody was buying them. Producers were not getting their money back and they stopped production of oranges.

Such a level of advancement, which could not go on for long and it had to stop at some point of time. Therefore, this could be seen as an example of unsustainable development.

This is a simplified example using the 'demand and supply' aspects. When other aspects are considered, the example can become more complex. We could, for example, have considered soil quality, the social aspects of labor involved in cultivating oranges, wages for labor and what happened to them when the market for oranges collapsed.

Look at another example with social aspects.

Consider a region where a pesticide manufacturing company has been set up. Its business is selling a certain type of pesticide to local farmers. For a time, the sale of pesticide would bring wealth to the industry. The farmers would get better harvests with fewer pest attacks, and they too would become richer. Everyone would gain. With greater incomes, the farming families would have opportunities for better nutrition. Children would go to school, and the families would buy more conveniences.

This would certainly be development.

However, if the pesticide is such that it remains in the mud and water and bio-accumulates, then the village may face health problems. Pests may become more resistant to pesticides; farmers would have to buy more and more quantities of pesticides. The result of continued use of such pesticides would be ill-health, greater spending on health care and reduced net incomes for farmers.

Thus, the development achieved in the short term may not continue over time and would be unsustainable.

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Most often, unsustainability is a combination of social losses and ecological degradation. In the above example of pesticides, the direct social losses are ill-health and reduced incomes. The ecological loss is the deprivation of the mud and marine contamination.

Exercise

List three environmental, social or economic trends that have impaired the progress or development of members of a community/village/town. In making this list, you could include lack of education, social divisions which reduce equality, lack of 'political voice', etc. As in the earlier exercise, write your list like this...

"I think the development of all members of my (or any other) community/village/town is impaired because..."

Concept of Sustainable Development

The United Nations set up the 'World Commission on Environment and Development' (WCED) in 1983, to propose long-standing ecological policies for progress. The WCED, in 1987, put forth this definition in their report called *Our Common Future:*

Sustainable development is a development that meets the wants of the present day by not negotiating on the capability of forthcoming generations to fulfil their own wants.

There are two key concepts in this definition:

1. The concept of 'needs' refers to the crucial wants of human beings. It draws attention to the fact that millions of people today do not have adequate food, or a proper house, clean drinking water, safe toilets, and basic education. The definition suggests that such essential needs of all people must be met as a precondition to 'sustainable development'.
2. That the pattern of development has to be such that future generations would also be able to meet their needs—this may include the productivity of various ecosystems, the availability of resources, the standard of the environment, the nature of the climate, etc.

Need for Sustainable Development for Improving Lives – Now and in the Future

Recall the explanation of maintainable growth and the two key concepts. The central idea is the security of all people – those in the present day, as well as for the upcoming future generations.

Another main idea for both these key concepts is equity.

Equity means that everybody must have equivalent chance for a basic income or livelihood (means of earning a living or subsistence) and equally good environmental quality. Equity implies that gains and losses are fairly distributed in society. No one has to suffer more than others if the environment is degraded.

Lack of equity is seen in the fact that poorer people tend to suffer the burden of environmental problems more than others do. More affluent people can spend extra money to reside in regions that do not have their atmosphere deteriorated yet. They can also build houses or infrastructure that can fight or guard against a polluted environment. They have surplus money, education, skills and decision-making powers.

Intra-generational equity refers to equity within the same generation – all people living in a generation should have the same access to the means of development and satisfying basic needs.

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Future

The past and present generation's usage of remnant fuels is changing the global climate. Rise in sea level is already seen in several coastal areas. Future generations are likely to have to live with severe droughts and floods.

In the Sundarbans in Bangladesh and India, the next generation of people living in low lying coastal areas can expect to lose their lands. Their chances of development are already reduced by activities they are not responsible for.

The concept of equity among people who live now, and people who will live in the future, is known as *inter-generational equity* (equity between two generations). This means that our actions today should not adversely affect the life and pleasure of future generations. This would be unfair to them. Those who are not yet born have no say in decisions that will affect them.

Tradition

The idea of 'sustainable development' is not new, because in many Indian (and in the traditional societies of other countries/regions) cultures and customs, people worship natural elements, keep some for other living creatures, and for the future.

Do you agree with this statement? Do traditional cultures promote the value of sustainable development, or are they only superstitious beliefs?

Concept of Sustainable Consumption

How is the concept of 'sustainable development' to be put into practice? Development is largely based on the use of resources. Therefore, a change in the pattern of development requires a change in the pattern of use of resources.

The concept of 'sustainable consumption' relates to both conventional and non-conventional resources. Economist Herman Daly suggests that:

1. For non-conventional sources of energy, reaping charges must not surpass renewal charges.
2. Waste matter releases must not surpass the assimilating measurements of the receiving environment.
3. Conventional sources of energy must be consumed not sooner than the proportion of making of non-conventional alternatives.
4. The natural resource base available for development is shrinking because consumption levels are so high that they are using up non-conventional sources of energy sooner than can be replenished.
5. Consumption patterns are causing pollution in quantities that are too large to be assimilated by the environment.
6. In 'Sustainable Agriculture', repeated and continuous farming for single crops depletes the soil of nutrients. Consistent application of agrochemicals can degrade the soil structure to such an extent that recovery may be very difficult. In this case, the soil and genetic (crop varieties) resources available to a community for agricultural development are reduced. This affects the level of development the community may achieve.

Conclusion

Traditional economic growth has intended making extra products by utilizing excess natural sources of energy, putting a growing stress on the environment. Continuing that

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type of financial development is not environmentally possible and cannot continue for long.

Economic activity does not necessarily result in human development, if the gains only reach a segment of the population.

Both consumption levels and the circulation of the advances from economic activity are critical determinants of the outline of development.

1. Concept of Sustainable Development

Environmental perspectives are now an integral part in development planning. GRO Harlem Brundtland in his report entitled *Our Common Future* (1987) gave new concept in development planning. He advocated the idea of "growth at all cost" be replaced by the idea of maintainable development.

Definitions

Maintainable growth has been explained in numerous manners.

1 *Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*

– **World Commission on Environment and Development (WECD)**

2. *Sustainable development is a process in which economic, fiscal, energy, agriculture and industrial policies are all designed to bring about a development that is economically, socially and ecologically sustainable.*

– **United Nation Development Project**

3. *Sustainable development ensures the future of improved quality of life through economic development giving full protection to the local environment.*

– **Authors**

4. *Sustainable development is the pattern of structural change in natural and man-made capital stock which ensures the feasibility of at least a minimum socially desired rate of growth in the long run.*

– **M. Karshenas**

The fourth definition gives different concept to sustainable development. It talks about least wanted degree of development by the society.

Evidently, no two countries can have the same minimum rate of growth. Consideration of this concept to third world countries, it would mean striving for such growth which will ensure providing the crucial wants of the society.

2. Need for Sustainable Development

The concern (need) about sustainable development is paramount because natural resources are depleting faster in Third World countries because of:

(a) High pressure of population

(b) Poverty

(c) Greater use of resources to increase production and thereby achieve greater production

(d) Increasing use of technology

Difficulties in the Application of Maintainable Growth

This idea has been widely accepted but the perception of the countries varies. One way to look at this concept is to look upon it as a very environment-friendly approach. At

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the opposite side of the range, there is the view to carry on with the business of development as usual and pay lip-service to it. This is because it is being realized that it is impossible to have economic development without any environmental impact.

It is, however, possible to limit the impact and, in some cases, to strengthen the beneficial impacts. Sustainable development as a goal was endorsed by 178 countries at the world conference in 1992 at **Rio-de-Janeiro.** However, the following problems need to be tackled (solved) before sustainable development becomes reality:

(a) The **planet earth** must be considered as a holistic unit. All the countries must come together and share the cost. The developing countries say that it is the developed countries who have brought about this **sorry state** of affairs by **uncontrolled and excessive development** in the past. So, they ask why should they share the costs.

(b) Our knowledge about the **physical environment is still inadequate**. We do not know the capacity of the ecosystems and the stage of **physical degradation**, the problems of soil erosion, flooding, depletion of water table, ozone depletion, etc.

(c) We also need to know how the use of **technology would be reduced in future.**

(d) It has been observed that **sustainable development and poverty** cannot co-exist. At the Stockholm Conference (1972) attended by 113 countries, Prime Minister **Indira Gandhi** was the only political **leader of importance.** She remarked that **lack of finances is the biggest contaminator.** Environment cannot be protected so long as countries remain poor. You cannot tell a villager who has no other energy source not to **cut trees for firewood.**

(e) There is no global political consensus for obtaining sustainable development. There is little **international cooperation.**

One more definition given by Gladin/Freeman (1994) **"Biophysically compatible and socially equitable improvement in the quality of life."**

The best probable definition becomes "durable change for better human conditions while protecting earth we inherit." In other words, "treating earth as if we intended to stay" concept is ideal but task is great. One has to bother about four objectives:

(a) Social progress that identify the need of everyone.

(b) Effective care (protection) of environment.

(c) Planned (careful) use of natural sources.

(d) To maintain required levels of economic growth (high and stable level).

The Rio Declaration aims at "a newfangled and unbiased international business by the making of fresh stages of cooperation among states". Out of its five significant agreements, **Agenda-21** proposes a global program of action on sustainable development in social, economic, and political context for the years to come (for the 21st century).

Key Aspects of Sustainable Development

1. **Inter-generational Equity:** It is giving more importance on the following points. We should minimize any undesirable (adverse) impact on environment and resources for incoming generations (future generations). In other words, we should hand over a healthy, safe, and resource-enriched atmosphere to our upcoming generations. It is probable if only we stop off **exploitation** (over) of **resources, reduction of waste matter release and discharge, and thereby maintain ecological balance.**

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2. **Intra-generational Equity:** It covers that the development system (process) should seek to minimize the breaches inside and amongst countries. Report of United Nations 2001 on Human Development applies importance to the aids of technological advances must pursue to obtain (achieve) **goals of intra-generational Equity.** The technology should tackle the problems of the developing countries, producing draught sustaining (tolerant) varieties or uncertain climates clean fuels for domestic and industrial applications, vaccines for infectious diseases. Such kind of technological development will favor the economic growth of the poor countries and **help in minimizing** (narrowing) the **wealth gap and support (leading) to sustainability.**
3. **Factors Responsible for Increasing Need of Sustainable Development (Challenges):** The following factors always affect the sustainable development (challenges):
   (a) Increasing trend of population.
   (b) Consumerism.
   (c) Industrialization

   (a) Population (Increasing Trend): The Population Clock: Every second, on an average, 4-5 children are born and 2 people die, thus resulting in net gain of nearly 2.5 person every second. This means that every hour we are growing by about 9000 and every day by about 2,14,000.

   Indian Scenario: India is the second most populous country with more than billion people (106 crore). If the present development proportion lasts, it will have 1.63 billion people by 2050 and will become the **most populated nation outstanding China**. Population explosion is causing **severe resource depletion and environmental degradation**. Our resources like water, land, fossil fuels, minerals, energy, etc. are limited and due to overexploitation, these resources are getting exhausted. **Man is the part of environment**. Environment gives everything that is essential for his development. It becomes very difficult to maintain sustainable balance between man and environment **because of rapid growth of human population**.

   (b) Consumerism: It is a problem faced by less developed countries and more developed countries (LDCs and MDCs). **Per capita use of natural resource is increasing.** Consumption trend is increasing worldwide because of communication network, TV, advertisement, etc. It leads to commercialization.

   (c) Industrialization: Less developed countries take more interest in industrialization. Here, government provides more facilities for industrial development. Economic development becomes the priority. Such pattern pays less attention towards rules and regulations to control environment pollution. Besides technology is old one. Ultimately, industries in LDCs are responsible for decreasing the standard of atmosphere. Industrial and economic growth are rising out quality of life but adding toxic pollutants in to air, water and soil. As an outcome, the ecological life support systems **are getting jeopardized**.

Clean Development Mechanism

Environmentalists have been warning that the spewing chimneys and vehicles are punishing the earth. Government finally took the notice and passed the **Kyoto Protocol** in 1997, which asked **signatory nations** to decrease greenhouse vapor releases to the

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1990 level by 2010. One phenomenon introduced to help countries in meeting their commitments was the Clean Development Mechanism (COM). "The COM allows government or even private entities in rich countries to set up **release lessening schemes in emerging nations. The investors get emission reduction certificate.**

India accounts for 4% of global emission and is the sixth major polluting country in the world. India is looking for COM partnership for eight projects worth ₹ 1,000 crore to reduce energy use. The project is a part of Japan to **reduce emission by 5%**.

Aluminium major Indalco is looking for partner to provide technology for fuel switching **(from coal to natural gas and propane)** and **reduce process emission by 80%**.

Aluminium is a prime energy intensive sectors where coal is the basic fuel. In 1960s itself, ACC had started using by-products like fly ash for manufacturing **blended cement.** But only 10% of the 100 million tons of fly ash produced a year in the country is used for **blended cement**. It is **three times** more durable than the limestone-based **Portland cement**.

Appropriate Technology (Application of Soft Technology)

It is increasingly felt that only technology which is suited and adapted to Indian conditions will **succeed and will be profitable**. It has been experienced that foreign technologies made available to developing nations are those which have become obsolete in their countries of origin and are high cost for consumers and not environment-friendly.

(a) The Noori Multi Fuel Lantern produces light output of a 100 W light bulb by using ethanol, diesel or kerosene while saving 40% fuel compared to that used by a petromax lamp. It can be also used for cooking.

(b) Old cycle, rickshaw system was without any improvement. Its operation affects the health of rickshaw puller. In the modified version, there are three gears, back wheel braking, better aerodynamics and more comfortable seating. By fitting a small electric motor, it has been converted into an electric rickshaw. European countries demand such kind of rickshaw (India-made model).

(This appropriate technology was developed by **Anil Rajvanshi** of the **Nimbkar Agricultural Research Institute**, **Phaltan**, recipient of **Jamnalal Bajaj Award** for Application of Science and Technology for Rural Development). The way to reduce environmental damage is to use "soft" technology. By soft technology, we mean using that technological procedure which is not harsh on the environment. Soft technology disturbs the **ecosystem** to the **least extent**. It uses the minimum amount of natural **resources**. **It gives time for nature to revise and revive itself**.

It creates less amounts of contaminants. It undertakes measures to process the waste matter goods so that they do not contaminate but are transformed to unharmful goods before they are released into the environment.

Our Role

If newfangled scheme of a big size is to be approved, the administration has made it obligatory to circulate the summary report of the **Environmental Impact Assessment** (EIA) and organize a 'public hearing'. It is important that all of us as accountable inhabitants read, assess and reply to such public hearings held in our area and make remarks on probable effects of the schemes. In many situations, there are proponents of the project who only look at their own rapid economic gains. It is for citizens as concerned individuals and groups to counter these vested interests so that our

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environment is not degraded further. We cannot support the economic growth of one sector of society while we permit environmental degradation to destroy the lives of the less fortunate.

5.2 Indicators of Sustainable Development

The indicators of maintainable growth are many. These indicators serve as **quantifiable tool** to assess, monitor and take corrective action in this regard. Some of the useful indicators for different sectors (areas) are given below:

1. **Transport:** Car use, number of short journeys and freight traffic.
2. **Economics:** Employment, inflation, and government borrowing and debt.
3. **Land Use:** Use of derelict land, urban development and green spaces.
4. **Water Resources:** Demand and supply of fresh water and rainfall.
5. **Forestry:** Tree health and forest cover.
6. **Climate Change:** Greenhouse gas emission and global temperature changes.
7. **Ozone Layer Depletion:** CFC consumption and measured ozone concentration.
8. **Acid Deposition:** NO_2 and SO_2 emissions.
9. **Air quality:** Pollutants emissions and expenditure on air pollution reactions.
10. **Fresh Water Quality:** Chemical and biological pollutants level.
11. **Marine Water Quality:** Oil spills, discharges and contaminants in fish.
12. **Wildlife and Habitat:** Animals and birds population and distribution, and habitat fragmentation.
13. **Agriculture:** Productivity, and use of fertilizers and pesticides.
14. **Soil:** Quality of soil and heavy metals in soil.
15. **Radioactivity:** Population exposure to radiation and nuclear power station discharges.
16. **Waste Generation:** Industrial and household waste, recycling and landfill waste.

Role of Government and Society towards Sustainable Development (Environmental Quality Objectives), i.e., EQCs.

A typical list of EQOs of an apex administrative body (viz., Government) can be as under:

(a) Clean air.
(b) Reduce climate impact due to pollution.
(c) Protect ozone layer.
(d) No acid rain (only Natural Acidification).
(e) Non-toxic environment.
(f) Total freedom from Nuclear Radiation.
(g) No eutrophication.
(h) Pollution-free water bodies (surface, ground and marine).
(i) Sustainable forest and apiculture.

Every sector of the society must assume its share of responsibility to implement these goals. Public agencies, organizations, enterprises and individuals must dedicate more consideration to ecological issues and **sustainable development**. Many small decisions affect the environment, and information, **education and evaluation** are

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therefore increasingly necessary. The Non-Governmental **Organizations** (NGOs) **are important stakeholder in this process.**

Summary Diagram of Environmental Impact Act

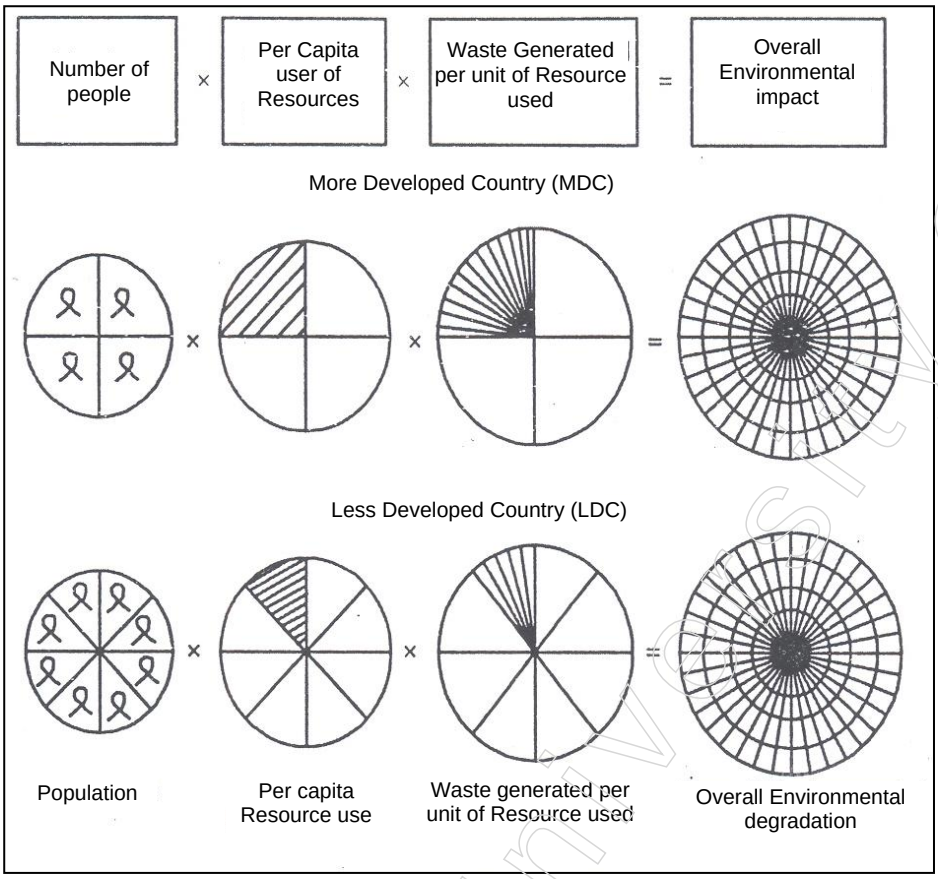

Fig. 5.1: Relationship of Population, Consumerism, Waste Matter Making and Ecological Effects

5.3 Sustainable Economic Growth

A much better understanding of the natural sources of energy is required. One must be familiar with environmental systems. These systems must support national economy. It should allow sustainable patterns of development. Government must determine and adopt the policies so that purpose can be achieved. **Success of the sustainable development includes:**

1. Ecological harmony.
2. Economic efficiency.
3. Conservation of resources including energy.
4. Local self-reliance.
5. Equity with social justice.

Few of the main targets that developed and developing nations need to set to achieve a sustainable society on sustainable economy are as follows:

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Table 5.1: Some of the Major Goals Leading to Sustainable Economy at Global Level

Developed Nation	Developing Nation
1. Population reduction is achieved	1. Population growth rate is stabilized and population reduced.
2. Reduction in resource consumption.	2. Sustainable agriculture system.
3. Increase in self-sufficiency.	3. Resources meet the basic need of the country.
4. Recycling and conservation are increased.	4. Restrain in adoption of western agriculture and technology.
5. Knowledge is shared with developing nation.	5. Promotion of universal literacy.
6. Peace and stability are achieved.	6. Maximum self-reliance is achieved.
7. Reduction in arms sale.	
8. Cooperation at global level.	
9. Sustainable ethics becomes reality.	

Sustainable economy can be achieved and succeed only with new policies, new political directions, education and awareness. The most fundamental changes would have to be an ethical shift promoted by parents, teachers and government agencies. Government can help by framing new laws that are conducive to the attainment of sustainable society. Therefore, overall shift to sustainable society with sustainable economy can come from a combination of personal and governmental efforts.

1. **Ways to Achieve Sustainable Economy:**
   - **(a) Education:** New social ethics should be indicated amongst children both in school and at home, emphasizing concern for environment, personal growth and peaceful coexistence. Economic growth should mean equitable and sustainable growth.
   - **(b) Population Control:** Amount of inhabitants' development should be controlled through education and awareness.
   - **(c) Resources:** Resources must be conserved through judicious use and recycled. Wherever possible, renewable resources should replace non-renewable resources.
2. **Ecological Aspect:** Numerous individuals in the manufacturing world nowadays function with "frontier mentality" which is a human-centered view based on three mistaken basic ideas:
   - (a) The world has unlimited supply of resources for human use.
   - (b) Humans are a part from nature.
   - (c) Nature is something to overcome.

With this attitude towards nature, technological advances upsurge our capability to use earth's resources and therefore, upsurge the harm. But the awareness is increasing fast that we are in world of restrictions, and ever-increasing progress of physical usage can only harm the life-giving substantial elements of the atmosphere.

Hence, the idea of **maintainable growth** takes us to newfangled resource usage policies which are:

(a) Preservation or decrease of extreme reserve usage.

(b) Reprocessing and recycle of material.

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(c) Extra usage of non-conventional resources such as solar energy rather than conventional resources like oil and coal.

Maintainable growth also needs fulfilling the crucial requirements of all underprivileged individuals in this world and spreading to all, the chances to fulfil their ambitions for improved lifestyle. Or else the world, in which deficiency and unfairness are widespread, will constantly be susceptible to environmental and additional disaster. In Gandhiji's words, "Earth provides enough to satisfy man's need but not any man's greed". The opinions of borderline community and maintainable community are compared in the following table.

Table 5.2: Comparison between Frontier and Sustainable Societies

Frontier Society	Sustainable Society
1. The earth has unlimited stock of resources.	1. The earth has limited supply of resources.
2. After the supply runs out at place move elsewhere.	2. Reprocessing, and usage of non-conventional resources will prevent depletion.
3. Constant adding to our physical prosperity will make lifestyle improved.	3. Life's value does not depend upon our material wealth.
4. The price of any scheme is determined by the price of materials, energy and labor.	4. The cost of product must include external costs such as damage to health and environment along with cost of energy, labor and material.
5. Nature is something to overcome.	5. We must understand nature and develop a symbiotic relationship
6. Ecological difficulties can be resolved by newfangled machineries and new rules.	6. We must all create awareness at personal level and also act to solve pressing problem.
7. We are above nature and superior to it.	7. We are part of nature and should abide by its rules.
8. Some waste is to be expected in all human activities.	8. Waste should be minimized by recycling as far as possible.

What is Acid Rain?

When atmospheric water droplets combine with a range of man-made chemical air pollutants, acid rain is formed. Other forms of precipitation like mist and snow may also be acidic for similar reasons.

The main pollutants involved are oxides of nitrogen and sulphur. In nature, volcanoes, fires, and decomposing matter emit these substances in small amounts. However, since the advent of the Industrial Revolution, human activities have been releasing such pollutants in large quantities. Such emissions are very high in the major industrial centers and have been increasing rapidly since the mid-twentieth century.

Automobiles and coal- and oil-fired power stations are major sources of acid-forming compounds. In fact, any burning of coal, oil, and (to a lesser extent) natural gas produces these compounds.

Acid rain ultimately falls on the ground, sometimes hundreds of kilometers from the area in which it formed and generally one to four days later. The effects of such acid rain are generally quite damaging.

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What is the Effect of Acid Rain?

When soil is acidified, it leads to a loss of productivity. The acidification damages plant roots and they are not able to draw in enough nutrients to survive and grow.

When trees, particularly conifers, are exposed to acid rain for several years, they begin to lose their leaves and die. This is one of several causes for the decline of forests in Europe, North America, and Japan. Plants like orchids, lichens and mosses are also very sensitive to acid fallout.

Acid rain falling on lakes and rivers destroy the life-forms that live in these water bodies. Thousands of lakes in Sweden, Norway and Canada, for example, have been permanently affected by acid fallout. Fish populations have died and so have species, such as otters, amphibians, and birds that depended on fish for their food.

Acid rain harms people directly when they breathe in the acidic air. Acid rain can also harm people indirectly, when they eat fish caught in acid rain affected lakes or rivers.

Old buildings are also threatened by acid rain. Add fallout has caused the famous St. Paul's Cathedral in London to decay more in the last 50 years than it has in the previous two centuries. Some famous statues, such as the Lincoln Memorial and Michelangelo's statue of Marcus Aurelius, have started deteriorating because of the effects of acid rain. The same is true for many historic buildings in Europe.

The Taj Mahal was also threatened by acid rain caused by factories in Agra. Thanks to the orders of the Supreme Court, many of these industries have been shifted or closed down.

A side-effect of acid rain is the leaching of aluminium out of the soil into water bodies. Aluminium is very toxic for fish and the birds that prey on them. Sometimes, acidification leads to the leaching of cadmium and this can also have adverse effects on animals.

What can be Done about Acid Rain?

In most cases, acid rain formed in one country falls on some other country. It is also difficult to prove that a particular country was responsible, or to quantify the amount of contributing pollution from a source.

Pouring powdered limestone into water bodies is a rapid, but short-lived, method of reducing acidity. A more permanent, but slow and expensive method is the liming of surrounding soils.

Some technologies for reducing emissions are flue gas desulphurization in power stations and catalytic converters and engine modifications in automobiles.

What is Ozone Layer Depletion?

Ozone is a toxic vapor made tip of particles comprising of three oxygen atoms. This gas is very rare in the atmosphere, representing just three out of every 10 million molecules. 90% of ozone occurs in the uppermost atmosphere, or stratosphere, between 10 km and 50 km above the Earth.

The ozone layer in the atmosphere soaks maximum of the damaging ultraviolet-B (UV-B) radiation from the Sun. It also totally shelters us from the fatal UV-C radiation. The ozone protection is therefore vital to guard life.

Exhausting the ozone layer allows more UV-B rays to reach the Earth. The outcome is an upsurge in skin cancers, eye cataracts, weakened immune systems,

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reduced plant yields, damage to ocean ecosystems and reduced fishing yields, and adverse effects on animals.

In the 1970s, scientists discovered that when CFCs (chlorofluorocarbons, used as refrigerants and aerosol propellants), ultimately break down in environment and emit chlorine atoms, they result in ozone exhaustion. Bromine atoms emitted by halogens (used in fire extinguishers) have the similar result.

The ozone layer over the Antarctic has progressively deteriorated since measurements started in the early 1980s. The property zone below the ozone-depleted atmosphere has amplified progressively to more than 20 million sq. km in the early 1990s and is wide-ranging between 20 and 29 million sq. km since then. In 2000, the area of the ozone hole reached a record 29 million sq. km.

While no hole has appeared elsewhere, the Arctic spring has seen the ozone layer over the North Pole thinning by up to 30%. The depletion over Europe and other high latitudes varies between 5% and 30%.

What are the International Initiatives against the Depletion of the Ozone Layer?

Inter-governmental discussions for a worldwide treaty to phase out ozone reducing elements started in 1981 and settled with the acceptance of the Vienna Convention for the Protection of the Ozone Layer in March 1985.

The Vienna Convention encourages inter-governmental cooperation on research, systematic observation of the ozone layer, monitoring of CFC production, and the exchange of information. The Convention commits the signatories to taking general measures to protect human well-being and the atmosphere compared to human actions that alter the ozone layer. It is an outline contract and does not comprise of lawfully obligatory regulations or goals.

The Convention did, however, set a significant example. For the first time, countries approved in opinion to attack a worldwide ecological issues before its effects were felt, or even methodically confirmed.

In May 1985, British scientists issued their finding of serious ozone exhaustion in the Antarctic. Their conclusions were checked by American satellite observations and presented the primary proof of serious ozone exhaustion. The detection of the 'Ozone Hole' surprised the world. It is observed as a foremost ecological tragedy of the 20th century.

Administrations today identify the necessity for powerful steps to decrease the manufacture and usage of a number of CFCs and numerous halons. As an outcome, the Montreal Protocol on elements that exhaust the ozone layer was approved in September 1987.

96 substances are currently measured by the Montreal Protocol and are issued to phase-out agendas under it. The Protocol was intended so that these agendas could be reviewed on the foundation of intervallic technical and scientific valuations.

Administrations are unlawfully tied by the Protocol until they approve it as well as the alterations to it. Inappropriately, while maximum administrations have approved the Protocol, approval of the alterations, with their powerful regulation steps, still pauses behind.

What Have Been the Results So Far?

The Montreal Protocol is functioning. Still, with the complete obedience with the Protocol by all parties, the ozone layer will continue to be predominantly susceptible of exhaustion during the next decade or so.

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In 1986, the total consumption of CFCs worldwide was about 1.1 million ODP (Ozone Depleting Potential) tons. By 2001, this had come down to approximately 110,000 tons. It has been considered that without the Montreal Protocol, worldwide usage would have touched approximately 3 million tons in the year 2010 and 8 million tons in 2060, that will result in huge ozone layer reduction.

Without the Protocol, there would have been an excess amount of UV-B radiation arriving on the Earth in the northern mid-latitudes and a quadrupling of the amount in the south. The amount of ozone-reducing substances in the environment would have been 5 times bigger. The consequences of this would have been dreadful.

The bulk of the 1986 total, or approximately 0.9 million ODP tons was used up in advanced nations, but by 2001, these nations used up just approximately 7000 tons. The emerging nations have lessened their CFC usage by about 15% between 1986 and 2001.

Scientists forecast that ozone exhaustion will spread to its severe phase in the coming few years and then slowly weaken till the ozone layer comes back to its usual state somewhere in 2050, assuming that the Montreal Protocol is completely applied.

The achievement of ozone conservation has been imaginable since science and industry have been capable to advance and commercialize substitutes to ozone exhausting substances. Advanced nations stopped the usage of CFCs quicker and with low price than was initially expected.

What Have Been the Lessons of the Montreal Protocol?

The hard work of the global community to guard the ozone layer is an enthralling case of how people can perform as one to eradicate a shared hazard. The Protocol provides numerous teachings that could be functional in resolving additional worldwide ecological problems:

- Follow the 'precautionary principle' because waiting for entire technical evidence can postpone act to the stage where the hazard becomes irreparable.
- Direct reliable and trustworthy signs to business (for instance, by accepting lawfully obligatory phase-out agendas) so that they have an encouragement to advance newfangled and profitable substitute machineries.
- Guarantee that better-quality technical consideration can be combined rapidly into conclusions about the supplies of the agreement.
- Encourage worldwide contribution by identifying the 'shared but distinguished accountability' of emerging and advanced nations and safeguarding the essential monetary and technical sustenance to emerging nations.
- Strong regulation steps on a combined valuation of science, economical and technology.

Is the Global Climate Changing?

Weather is the state of the troposphere at a specific location and period. It is considered by constraints like the temperature, humidity, rain and wind. Weather is the long-standing outline of climatic situations for a specified zone.

Until the middle of the twentieth century, the earth's climate was generally regarded as unchanging, but it is now known to be in a continuous and delicate state of flux. Relatively small changes in climate could have a major effect on our resources like food, energy and water.

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The factors that influence global climate are the quantity of energy from sunrays the Earth receives, the state of the atmosphere, the shape and rotation of the Earth, and the currents and other processes of the ocean.

What is Global Warming and How Does it Occur?

Recall the way the carbon cycle works. During photosynthesis, plants absorb carbon dioxide and emit oxygen. Organisms breathe in this oxygen, and give out carbon dioxide, which goes back to the plants. This is the carbon cycle in brief.

Usually, carbon dioxide and additional vapors that mount on the earth let the energy from the sun spread on it, but avert some of the heat from being reflected back again. In the absence of these greenhouse gases, the Earth would be very cooler and mainly shielded with snow. The issue arises when the quantities of these vapors surpass a specified edge.

By burning large amounts of fossil fuels, we release huge quantities of carbon dioxide into the atmosphere. Concurrently, deforestation also releases carbon trapped in the tissues of the trees. Simultaneously, damage of trees decreases the Earth's ability to soak carbon dioxide through photosynthesis. Natural courses like lava outbreaks and earthquake persuaded fires also lead to carbon dioxide releases.

Some of the other greenhouse gases are far more effective than carbon dioxide in trapping heat. Chlorofluorocarbons (CFCs) are an example, but their role is greater in the depletion of the ozone layer. Methane, emitted from swamplands, man-made and animal waste matter and trash junkyards, is also a greenhouse vapor and its absorption in the environment is growing. Similarly, human activities are causing a rapid increase in the amounts of 30 other greenhouse vapors in the troposphere.

The abnormal increase in the absorptions of these vapors leads to higher temperatures and global warming. The average temperatures around the world have risen by about 0.5°C since the beginning of the 20th century. If emissions continue at the current rate, a temperature rise of 1.5°C to 4.5°C is likely by 2030.

From Which Countries Do the Human-Induced Greenhouse Gas Emissions Come?

Most of the greenhouse gas emissions come from the northern hemisphere, the US being the biggest contributor. Russia is also a major source. European nations also create considerable quantities of greenhouse vapors, but they are also attempting to decrease releases.

Emerging nations are rapidly coping up with advanced nations when it comes to greenhouse gas releases. China and India are industrializing quickly and their releases are expected to duple in the coming two decades.

What will be the Effects of Global Warming?

An increase of just 1.5°C in global temperature could cause changes greater than anything experienced during the last 10,000 years. Regional and seasonal weather patterns will change, with longer warm periods and shorter cold seasons.

Dangerous climatic circumstances like inundations and famines are expected to arise more frequently. Many believe that this effect is already noticeable. In fact, there have been an unprecedented number of natural disasters in the 1990s. During that decade, the weather-related damage was five times greater than in the 1980s. Additional such actions will quicken soil corrosion and desertification, which could disturb global farming and damage food security.

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The ocean will become warmer, its waters will expand, and sea levels will rise. The possible melting of Polar ice caps will add to the problem. Seaside parts will be inundated in countries such as the Netherlands, Egypt, Bangladesh and Indonesia, requiring the removal of numerous inhabitants. Minor islands like those of the Maldives and many of the islands in the South Pacific might vanish.

"I feel sad and angry. Sad that we have to move, Angry because it is doing or others who do not care."

The above words are that of Paani Laupepa, the Assistant Secretary for the Environment, Tuvalu. He was referring to the soon-to-come evacuation of Tuvalu before it disappears into the ocean as the world's first casualty of global warming.

Tuvalu is a chain of nine coral islands in the South Pacific with a total area of 25 sq. km and a population of 11,000. It is one of the smallest and most remote countries, halfway between Hawaii and Australia. It is a paradise of chalk-white beaches and coconut palms. Soon, however, it will be a paradise lost.

Rising sea level are already a fact in Tuvalu. The islands are made of porous fossil coral and water has started flowing up through holes in the ground. The tides are higher and the storms are more frequent and severe.

The people, who survive on subsistence agriculture and fishing, are ready to migrate. While Australia has refused them permission, New Zealand is taking in 75 persons every year.

Prime Minister Koloa Talake has hired law firms in the US and Australia to file a case against greenhouse gas emissions at the International Court of Justice at the Hague.

Leave they must, sooner or later. When they leave, who will compensate them for the loss of their entire culture.

Numerous flora and fauna breeds will go non-existent, as they are incapable to alter rapidly to changing situations. Arctic breeds may be the first to go, followed by those in the coastal zones everywhere.

On the whole, a grim future awaits the Earth if the current rate of release of greenhouse vapors remains. Even if these emissions were drastically decreased now, the effects of past emissions will continue for a long time. Yet, countries like the US are unwilling to sacrifice some comforts today in order to avoid catastrophe tomorrow.

Is There any Doubt that Global Warming is Occurring?

There is no dispute about the increased accumulation of greenhouse vapors in the troposphere. There is, however, a minority who believe that our understanding of climate is insufficient to allow us to make any predictions of global warming. Most scientists agree with the environmentalists that the unchecked upsurge in greenhouse vapors is too great a risk to take. Meanwhile, more and more studies confirm that global warming is a reality.

In 1992, over 1600 distinguished scientists (including 104 Nobel Laureates) issued a statement called the *World Scientists Warning to Humanity.* This was a warning to the world about rapid environmental degradation. The following are two key sentences in the statement:

- 'Human beings and the natural world are on a collision course'.
- 'We should stop the usage of remnant fuels to cut greenhouse vapor releases'.

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The Inter-governmental Panel on Climate Change (IPCC), a task force of climate scientists from nearly 100 countries, also came to a clear conclusion that global warming was indeed occurring, in its 1995 report. This report, with 78 lead authors and 400 contributors from 26 countries, came to the following serious conclusions:

- Global warming is happening.
- Human activity is causing it.
- Global warming is likely to unleash unnatural and devastating storms, floods, heat waves, droughts, etc.
- Carbon dioxide emissions must be cut, particularly in the industrialized nations.

Many other studies have come to similar conclusions. In November 2004, new evidence of global warming come horn a four-year study sponsored by the United Nations Environment Programme (UNEP), which was conducted by an international team of 300 scientists.

The study, called the **Arctic Climate Impact Assessment**, predicts that greenhouse vapors from man-made actions are likely to contribute to a global temperature increase of 3°C to 9°C over the next 100 years. The Arctic region is an indicator of global climate change and provides early warning of events worldwide. It is certainly getting warmer at the poles and glaciers are melting in many parts of the world.

5.4 Found: Dead Bodies and Ancient Mummies

In Norwegian cemeteries, bodies of those killed by flu and smallpox early last century are surfacing. In the Italian Alps, passing hikers found a Neolithic Iceman, a 5300-year-old mummified body.

The reason being, the permafrost is melting and revealing long-kept secrets. As its name implies, the permafrost is not supposed to melt. It is a perennially frozen layer of the soil. Any rock or soil remaining at or below 0^{o}C for two or more years is permafrost. Almost 20% of the world's land surface is composed from the permafrost and most of it is in the Arctic.

Frozen organic matter in the permafrost holds one-sevenths of the world's carbon. Its release could dramatically increase the concentrations of carbon dioxide in the atmosphere.

The ice is melting at the Poles. In Alaska, temperatures have increased by an average of 2°C since the 1950s. All permafrost below the Yukon has warmed and roads and buildings are buckling. Greenland has been losing 50 cu. km of water per year from its vast ice sheet.

The thaw at the North Pole in 2002 exceeded all records. The sea ice was the thinnest in 40 years. When the ice is thin, reduced sunrays are mirrored back, more radiation is absorbed by the water, and temperatures go up.

In Antarctica, the temperature is behaving oddly. It is stable in some parts, dropping slightly in others, and rising on the peninsula. In March 2002, 1250 sq. m section of the Larsen B ice shelf collapsed.

The world's glaciers are melting everywhere. In Glacier Park, Montana, in the US, of the 150 glaciers it had in the nineteenth century, only 35 remained. The famous snows of Mt Kilimanjaro in Africa are vanishing.

The snow peaks of the Andes in South America are melting fast. Bolivia and Peru depend on them for drinking water, irrigation, and hydropower. In fact, Lima in Peru, the

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second largest desert city in the world after Cairo, is totally dependent on the water from the glacier. Over the past 30 years, 800 million cu. km of water has been lost from the ice fields above Lima. A huge chunk of the glacier is threatening to fall into Lake Palcacocha in Peru and if it does, it will flood Huaraz, a city of 60,000.

In Bolivia, the glacier Qori Kalis is retreating at the rate of 60 cm a day. Paul Rauber writes, 'Sit beside the mighty Qori Kalis on a warm afternoon and watch the Ice Age melt before your eyes.' Scary, isn't it?

(**Source:** Rauber (2003), Lynas 2004.)

Crisis: The Vanishing Snows

'Wide as all the world, great, high, and unbelievably white in the sun.' That is how Ernest Hemingway once described these ice fields. They are today vanishing before our eyes.

In January 2003, amateur adventurer Vince Keipper realized a long-time goal when he trekked to the top of the mountain. 'The sound brought our group to a stop,' Keipper recalls. 'We turned around to see the ice mass collapse with a roar. A section of the. glacier crumbled in the middle, and chunks of ice as big as rooms spilled out on the crater floor.'

Keipper was in the right place at the right time to get a photo of the crumbling Furtwangler Glacier on Mt. Kilimanjaro. The photo is dramatic evidence of the glacier's recession. Big blocks of ice tumbled across the trail Keipper had hiked the day before.

Mt. Kilimanjaro in Tanzania is the highest mountain in Africa, almost 5900 m high. The top of the mountain is covered with snow formed more than 11,000 years ago. This snowcap makes Kilimanjaro one of the most recognized landmarks of Africa.

The mountain rises above flat land, called the Savannah. The property is a habitat to numerous diverse types of faunas. Earliest views in Africa study that the mountain is a divine location.

The snow and ice on the summit of Mt. Kilimanjaro is now melting so fast that some scientists believe its ice cap could be gone by the year 2015. The ice cap has shrunk from about 12 sq. km in 1912 to about 2 sq. km in 2003, a decrease of 80%.

There is concern that the loss of Kilimanjaro's ice cap could impact both the local climate along with the obtainability of pure water for local populations who depend upon the glacial melt runoff, particularly during the dry seasons. It will also affect agriculture and hydroelectric production. As Tanzania's top tourist attraction, drawing 20,000 tourists a year, the country's foreign currency earnings will also be hit.

Most predictions of global climate change suggest that early signs of warning will be seen at high elevations where these ice caps exist. It is, however, not clear if global warming explains the melting of Kilimanjaro's ice.

Some scientists trust that woodland decrease in the parts nearby Kilimanjaro, and not global warming, could be the most powerful man-made effect on ice decline. Fires and the clearing of land for agriculture have greatly reduced the surrounding forests. The damage of greenery reasons in a smaller amount of moistness to be driven into the troposphere, causing in decreased cloud protection, rainfall, amplified solar energy and ice disappearance.

Scientists are scrambling to learn as much as they can from a vanishing resource. Kilimanjaro's glaciers are the only source of tropical ice core records for the whole continent of Africa. The glacial ice core samples hold vital atmospheric and climatic records – information that is key to understanding tropical weather patterns over the past millennia.

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Can the melting be halted? Scientists are willing to try. Some have suggested covering Kilimanjaro's ice cap with a bright white cover (inspired by those used in England to protect cricket fields from the elements), a membrane, which will seal the glaciers, preventing evaporation and reflecting solar radiation. The Furtwangler Glacier may continue to disappear in large chunks. The rest of Kilimanjaro's ice cap will follow suit, but rather than exploding, it will steadily and stealthily evaporate into the African air.

(**Source:** NASA Site.)

The main force behind creating doubts about warnings regarding the occurrence of global warming was a group called the Global Climate Coalition (GCC). This group represented more than 100 major corporations of the world from the coal, oil, power, automobile, and chemical industries.

The GCC was set up to protect the interests of the major companies that benefit from the large-scale use of fossil fuels. Through sustained advertisement campaigns and heavy lobbying, GCC has tried to counter scientific evidence of global warming. It has effectively undermined public support in the US for efforts to stabilize climate.

The GCC, however, has lost its major members as corporations changed their attitudes toward the environment. Companies like British Petroleum, DuPont Royal Dutch Shell, Ford, Daimler Chrysler, Texaco and General Motors have left the group, and have embraced environmental goals of their own.

What are the International Initiatives to Control Global Warming?

It is unlikely that global warming can be avoided, but we can reduce its adverse effects. Immediate and drastic reduction of emissions, as recommended by the IPCC, is the need of the hour.

Energy preservation, advancement of non-conventional resources, a smaller number of vehicles, better backing for civic transport, decreased desertification, clean machineries, and alike steps are immediately required. The most important international initiative in this regard is the Kyoto Protocol.

What is the Kyoto Protocol?

The Kyoto Protocol is a legally binding international agreement to decrease greenhouse gas releases. It was initially negotiated during a meeting held in Kyoto, Japan, in 1997. The Protocol commits industrialized countries to dropping releases of 6 greenhouse vapors by 5% by 2012. Some of the reduction targets are for the US (7%), the European Union, Switzerland (8%), Canada and Japan (6%), each.

The Agreement specifies that all parties to the Protocol must follow a number of steps, some of which are given below:

1. Design and implementation of weather difference moderation and adaptation programs.
2. Preparation of a national inventory of emission removal by carbon sinks.
3. Promotion of climate-friendly technology transfer.
4. Fostering partnerships in research and observation of climate science, impacts and response strategies.

Emerging nations are not lawfully tied to releases decrease goals as yet, because these nations have factually been accountable for only a minor share of the global greenhouse vapor releases.

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Even if the Kyoto Protocol were to be fully implemented, it would do very little to solve the problem of carbon dioxide emissions. The IPCC had stated in its report that the emissions have to be cut by 60-80% if the climate is to be stabilized.

Many countries including India have ratified the Protocol. The US, however, has not accepted even the modest requirement of a 7% reduction. In November 2004, Russia approved the Kyoto Protocol and, as an outcome, the treaty will come into force by early 2005.

Global warming and other environmental problems are likely to cause displacement of large populations. In fact, displacement and resettlement are already major issues and that is the topic of the next section.

5.5 The Indian Context

India has still to go a long way in applying the idea of maintainable growth. We have to lay importance on bordering a well-organized plan for our developing action while growing our financial progress. We have an incredible natural variety along with enormous inhabitants which makes development for maintainable progress very significant and multifaceted. The National Council of Environmental Planning and Coordination (NCPC) set up in 1972 was the focal agency in this regard. The Ministry of Environment and Forests, set up in 1985, has formulated guidelines for various developmental activities keeping in view the sustainability principles.

Urban Problems Related to Energy

Metropolises are the main centers of financial development, business, education, innovations and employment. Until lately, a large majority of human population lived in rural areas and their financial actions centered around agriculture, cattle rearing, fishing, hunting or some cottage industry. It was some 200 years ago, with the dawn of Industrial era, the cities displayed fast growth. Now about 50% of the world population lives in urban areas and there is growing movement of rural folk to cities in search of job opportunities. The city development is so quick that it is becoming problematic to lodge all the manufacturing, commercial and housing conveniences inside a restricted civic border. As a result, there is spreading of the cities into the sub-urban or rural areas too, a phenomenon known as *urban sprawl.*

In emerging nations too, city development is rapid, and in most of the situations, it is overpowering and unintended development. In contrast to the rural set-up, the urban set-up is tightly inhabited, uses a lot of energy and materials, and produces a lot of waste matter.

The energy wants of city inhabitants are greater than that of rural ones. This is because city individuals have an advanced standard of life and their lifestyle demands more energy inputs in every sphere of life. The energy demanding activities include:

- Residential and commercial lighting.
- Transportation means including automobiles and public transport for moving from residence to workplace.
- Modern lifestyle using a large number of electrical gadgets in everyday life.
- Industrial plants using a big proportion of energy.
- A large amount of waste generation which has to be disposed properly using energy-based techniques.
- Control and prevention of air and water pollution which need energy dependent technologies.

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Due to high population density and high energy demanding activities, the urban problems related to energy are much more magnified as compared to the rural population.

5.6 Water Conservation

Water, being one of the most valuable and crucial resources, needs to be preserved.

The following strategies can be adopted for conservation of water.

(i) Decreasing Runoff Losses: Huge water loss occurs due to overflow on most of the soils, which can be decreased by letting most of the water to penetrate into the soil. This can be attained by means of contour cultivation, terrace farming, water spreading, chemical treatment or improved water storage system.

- **Contour cultivation** on small furrows and ridges across the slopes trap rainwater and allow more time for infiltration. Terracing constructed on deep soils have large water-storage capacity. On gentle slopes, trapped runoff is spread over a large area for better infiltration.
- **Conservation-bench terracing** includes building of a sequence of seating for catching the overflow water.
- **Water spreading** is done by channeling or lagoon levelling. In channeling, the water flow is controlled by a series of diversions with vertical intervals. In lagoon levelling, small depressions are dug in the area so that there is temporary storage of water.
- **Chemical wetting agents (surfactants)** upsurge the water consumption levels when added to normal irrigated soils.
- **Surface crop residues, tillage, mulch, animal residues, etc.** help in dropping overflow by letting more time for water to infiltrate into the soil.
- **Chemical conditioners** like gypsum **($CaSO_4.2H_2O$)** when applied to sodic soils improve soil permeability and reduce runoff. Another useful conditioner is HPAN (Hydrolyzed Polyacrylonitrile).
- **Water-storage structures** like farm ponds, dug-outs, etc. built by individual farmers can be useful measures for preserving water through decrease of overflow.

(ii) Reducing Evaporation Losses: This is more relevant in humid regions. Horizontal barriers of asphalt placed below the soil surface increase water availability and increase crop yield by 35-40%. This is more effective on sandy soil but less effective on loamy sand soils.

A co-polymer of starch and acrylonitrile called 'super slurper' has been reported to absorb water up to 1400 times its weight. The chemical has been found to be useful for sandy soils.

(iii) Storing Water in Soil: Storage of water takes place in the soil root zone in humid regions when the soil is wetted to field capacity. By leaving the soil fallow for one season, water can be made available for the crop grown in next season.

(iv) Reducing Irrigation Losses:

- Use of lined or covered canals to reduce seepage.
- Irrigation in early morning or late evening to reduce evaporation losses.
- Sprinkling irrigation and drip irrigation to conserve water by 30-50%.

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- Growing hybrid crop varieties with less water requirements and tolerance to saline water help conserve water.

(v) Reuse of Water:

- Treated wastewater can be used for ferti-irrigation.
- Using grey water from washings, bathtubs, etc. for watering gardens, washing cars or paths help in saving fresh water.

(vi) Preventing Wastage of Water: This can be done in households, commercial buildings and public places.

- Closing taps when not in use.
- Repairing any leakage from pipes.
- Using small capacity flush in toilets.

(vii) Increasing Block Pricing: The consumer has to pay a proportionately higher bill with higher use of water. This helps in economic use of water by the consumers.

5.7 Rainwater Harvesting

Rainwater harvesting is a technique of increasing the recharge of groundwater by capturing and storing rainwater. This is done by constructing special water-harvesting structures like dug wells, percolation pits, lagoons, check dams, etc. Rainwater, wherever it falls, is captured and pollution of this water is prevented. Rainwater harvesting is not only proving useful for poor and scanty rainfall regions but also for the rich ones.

The annual average rainfall in India is 1200 mm. However, in most places, it is concentrated over the rainy season, from June to September. It is an astonishing fact that Cherrapunji, the place receiving the second highest annual rainfall as 11000 mm still suffers from water scarcity. The water flows with runoff and there is little vegetation to check, the runoff and allow infiltration. Till now, there is hardly any rainwater harvesting being done in this region, thereby losing all the water that comes through rainfall.

Rainwater harvesting has the following objectives:

(a) To reduce runoff loss
(b) To avoid flooding of roads
(c) To meet the increasing demands of water
(d) To raise the water table by recharging ground water
(e) To reduce groundwater contamination
(f) To supplement groundwater supplies during lean season.

Rainwater can be mainly harvested by any one of the following methods:

(a) By storing in tanks or reservoirs above or below ground.
(b) By constructing pits, dug wells, lagoons, trench or check dams on small rivulets.
(c) By recharging the groundwater.

Before adopting a rainwater harvesting system, the soil characteristics, topography, rainfall pattern and climatic conditions should be understood.

(c) Amity University Online

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Traditional Rainwater Harvesting

In India, it is an old practice in high rainfall areas to collect rainwater from rooftops into storage tanks. In foothills, water flowing from springs are collected by embankment type water storage. In Himalayan foothills, people use the hollow bamboos as pipelines to transport the water of natural springs. Rajasthan is known for its *'tankas'* (underground tanks) and *khadins* (embankments) for harvesting rainwater.

In our ancient times, we had adequate *Talaabs, Baawaris, Johars, Hauz*, etc. in every city, village and capital cities of our kings and lords, which were used to collect rainwater and ensured adequate water supply in dry periods.

Modern Techniques of Rainwater Harvesting

In arid and semi-arid regions, artificial ground water recharging is done by constructing shallow percolation tanks. Check dams made of any suitable native material (brush, poles, rocks, plants, loose rocks, wire nets, stones, slabs, sacks, etc.) are constructed for harvesting runoff from large catchment areas. Rajendra Singh of Rajasthan popularly known as "Water Man" has been doing a commendable job for harvesting rainwater by building check dams in Rajasthan and he was honored with the prestigious Magsaysay Award for his work.

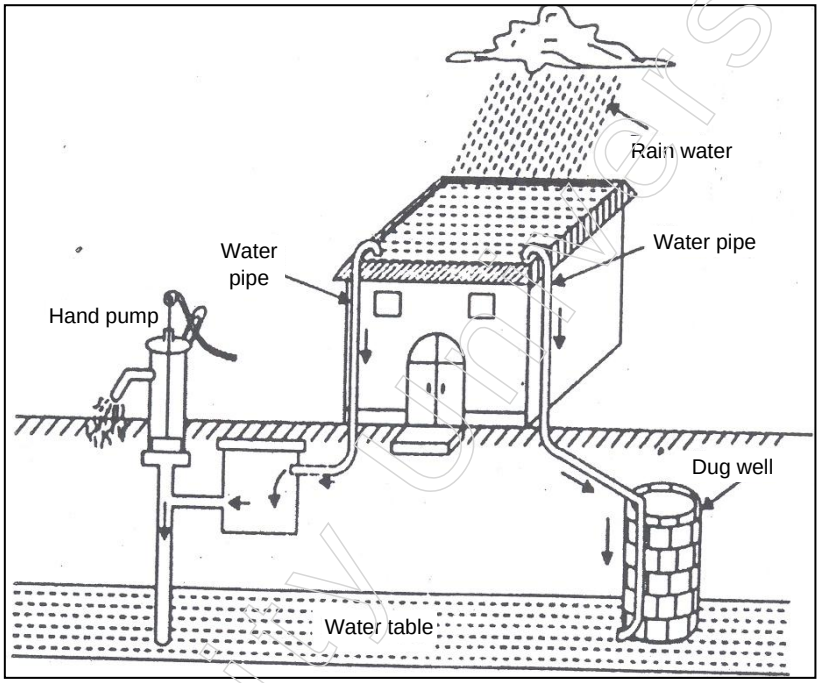

Fig. 5.2: Rooftop Rainwater Harvesting by Recharging: (i) Through Hand Pump or (ii) through Abandoned Dug Well

Groundwater flow can be intercepted by building groundwater dams for storing water 'underground'. As compared to surface dams, groundwater dams have several advantages like minimum evaporation loss, reduced chances of contamination, etc.

In rooftop rainwater harvesting, which is a low-cost and effective technique for urban houses and buildings, the rainwater from the top of the roofs is diverted to some surface tank or pit through a delivery system which can be later used for several purposes. Also, it can be used to recharge underground aquifers by diverting the stored water to some abandoned dug well or by using a hand pump.

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All the above techniques of rainwater harvesting are low-cost methods with little maintenance expenses. Rainwater harvesting helps in recharging the aquifers, improves groundwater quality by dilution, improves soil moisture and reduces soil erosion by minimizing runoff water.

5.8 Watershed Management

The land part exhausted by a river is known as the river basin. **The watershed is defined as the terrestrial part from where the water drains under gravity to a common drainage channel. Thus, watershed is a delineated area with a well-defined topographic boundary and one water outlet.** The watershed can range from a few square kilometres to few thousand square kilometres in size. In the watershed, the hydrological situations are such that water becomes intense within a specific place like a stream or a artificial lake, by which the watershed is exhausted. The watershed comprises complex interactions of soil, landform, vegetation, land use activities and water. People and animals are an integral part of a watershed having mutual impacts on each other. We may live anywhere; we would be living in some watershed.

A watershed disturbs us as it is directly tangled in constant food manufacture, water supply for irrigation, electricity generation, transport as well as for persuading sedimentation and corrosion, flora development, inundations and famines. Thus, management of watersheds, treating them as a basic functional unit, is extremely important and the first such Integrated Watershed Management was adopted in 1949 by the Damodar Valley Corporation.

Watershed Degradation: The watersheds are very frequently found to be tarnished due to unrestrained, unintended and irrational land usage actions. Overgrazing, desertification, removal, building actions, industrial development, everchanging farming, natural and artificial fires, soil corrosion and unawareness of local individuals have been accountable for deprivation of numerous watersheds.

Objectives of Watershed Management: Balanced consumption of property and water resources for best manufacture instigating least harm to the natural resources is known as watershed management. The objectives of watershed management are as follows:

(a) To assimilate the watershed through proper land use accepting preservation plans for minimizing soil corrosion and moistness holding so as to safeguard good output of the land for the farmers.

(b) To manage the watershed for helpful developing measures like domestic water supply, irrigation, hydropower generation, etc.

(c) To minimize the dangers of inundations, famines and landslips.

(d) The progress of rural zones in the areas with strong strategies for refining the budget of the area.

Watershed Management Practices

In the Fifth Five Year Plan, watershed management method was comprised with a number of programmes for it and a national policy was developed. In watershed management, the features of expansion are measured with regards to the obtainability of natural assets.

The approaches of preservation and expansion of land and water are taken up with the regards to their aptness for societies' advantage along with endurance. Numerous procedures undertaken for organization comprise of the following:

(c) Amity Directorate of Distance and Online Education

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1. **Water Harvesting:** Correct storing of water is done with providing usage in dry seasons in little precipitation zones. It also aids in control of inundations.
2. **Afforestation and Agroforestry:** In watershed growth, afforestation and crop plantation perform a very significant part. They benefit to avert soil corrosion and holding of moistness. In high precipitation zones, woody trees are grown in between crops to significantly decrease the overflow and damage of productive soil. In Dehradun, trees like *Eucalyptus* and *Leucaena* and grasses like *Chrysopogon* are grown along with maize or wheat to achieve the above objectives. Woody trees grown successfully in such agroforestry programmes include *Dalbergia sissoo* (Sheesham), *Tectona grandis* (Teak) and *Acacia nilotica* (Keekar) which have been used in watershed areas of river Yamuna.
3. **Mechanical Measures for Reducing Soil Erosion and Runoff Losses:** Numerous motorized procedures like terracing, bunding, bench terracing, no-till farming, contour cropping, strip cropping, etc. are applied to lessen overflow and soil corrosion mainly on the hills of watersheds. Bunding has demonstrated to be a very beneficial technique in dropping overflow levels, top release and soil damage in Dehradun and Siwaliks.
4. **Scientific Mining and Quarrying:** Because of inappropriate removal, the mountains drop off constancy and get distressed causing landslips, fast corrosion, etc. Contour trenching at an interval of 1 metre on overburden dump, planting some soil binding plants like Ipomoea and Vitex, and draining of water courses in the excavated zone are suggested for reducing the damaging impacts of mineral removal in watershed parts.
5. **Public Participation:** People's participation counting in the farmers and tribal is the solution to achieve any watershed management programme, predominantly the soil and water preservation. People's assistance as well as contribution has to be safeguarded for the same. The communities are to be inspired for defending a newly planted zone and upholding a rainwater gathering construction applied by the administration or some outside agency (NGO) self-sufficiently or by connecting the local people. Correctly educating the people about the campaign and its aids or sometimes paying certain incentives to them can help in effective people's participation.

Successful watershed management has been done at Sukhomajri Panchkula, Haryana through active participation of the local people.

Watershed management in Himalayan region is of crucial significance since most of the watersheds of our country lie here. Numerous man-made caused actions quicken its grade variability which requires to be prohibited and hard work should be made to defend the watershed by averting overgrazing, terracing and contour farming to check runoff and erosion, etc. On steeper slopes with sliding faces, straw mulching tied with thin wires and ropes helps in establishing the vegetation and stabilizing the slopes.

5.9 Resettlement and Rehabilitation of People: Problems and Concerns

Problems and Concerns

Financial growth increases the superiority and standard of living of the people of a country. Developing schemes are planned to bring benefits to the society. Though, in the course of growth, very frequently, there is overexploitation of natural resources and deprivation of the atmosphere. Also, very frequently, the native individuals of the plan location are directly affected. These native individuals are usually the underprivileged

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tribal people. Numerous kinds of schemes outcome in the movement of the native individuals who experience incredible financial and mental suffering, as the socio-economic and environmental base of the native public is distressed.

Displacement Problems Due to Dams

The big stream valley schemes have one of the very severe socio-economic effects due to large-scale movement of native individuals from their family home and damage of their old-style career or profession. India is one of countries in the world which is foremost in large dam building, and in the last 50 years, more than 20 million people are projected to have been directly or indirectly impacted by these dams.

The **Hirakund Dam** has displaced more than 20,000 people residing in about 250 villages. The **Bhakra Nangal Dam** was constructed during 1950s, and till now, it has not been possible to rehabilitate even half of the displaced persons.

Same is the case with **Tehri Dam** on the river Bhagirathi, construction of which was green signaled after three decades of long campaign against the project by the noted activist Sunderlal Bahuguna, the propagator of **Chipko Movement.** The immediate impact of the Tehri Dam would be the 10,000 residents of the Tehri town. While displacement is looming large over the people, rehabilitation has become a more burning issue.

Case Study – 1:

The much-debated **Sardar Sarovar Project** which plants to build 30 big, 135 medium and 3000 minor dams on the Narmada river and its tributaries is projected to immerse nearly as much part as it is intended to irrigate. A total of 573 villages, consisting of about three lakh people are going to be affected due to submergence under water. As an outcome of the big dams, the community rights of the tribal people is breached. It is a traumatic experience to get uprooted from one's native place where its generations have lived and move to a new place as a total stranger. Very often the family breaks up. It is a huge amount that tribal people pay for a large dam scheme which is made-up to bring joy and wealth to the nation. In return of this immense loss, the tribal people must be given suitable reimbursement in the form of property, careers, money reward, etc. and care should be taken to advance their quality of life.

Displacement Due to Mining

Excavation of minerals is another developing programme, which causes movement of the tribal people. Numerous thousands of hectares of terrestrial parts are roofed in removal process and the tribal people are evacuated. Occasional dislocation of tribal people is because of mishaps taking place in excavated parts like subsiding of property that frequently results in relocation of individuals.

Case Study – 2:

Jharia Coal Fields, Jharkhand is posing a large problematic situation to the local residents due to underground fires and, they are asked to evacuate the region. The application of large-scale removal of approximately 0.3 million inhabitants of Jharia instantly increases the query of their replacement and reintegration for which correct arrangement is mandatory. Some 115 crores of rupees have been spent to put out the fires since 1976, still the problem persists. The of people of Jharia are being asked to vacate the zone, but till now there is no substitute property and reintegration is ready. As an outcome of it, the local people have formed hesitations that they are going to be left in the lurch. The newest estimations display that about ₹ 18,000 crores will be spent for

shifting the Jharia inhabitants while the price for quenching the fire would be approximately ₹ 8,000 crores. Possibly technical firefighting will avert the Jharia inhabitants from experiencing the suffering of dislocation.

Displacement Due to Creation of National Parks

When some woodland part is protected under a National Park, it is a welcome step for preservation of the natural resources. Still, it also has a communal feature related with it which is frequently mistreated. A main share of the woodland is open as core area, where the admission of resident inhabitants or tribal people is forbidden. When these inhabitants are disadvantaged of their family rights or admission to the woodlands, they typically react by initiating damaging actions. There is a requirement to look into their difficulties and offer them jobs.

Case Study – 3:

The tribal people belonging to Tharu Community in 142 villages in Bihar in the **Valmiki Tiger Reserve** area in the district of west Champaran feel that they have been disadvantaged of their genuine family rights to gather wood logs and food from the woodland. Their jobs are also lost due to the 'Project Tiger' initiative. The unemployed inhabitants feel resentful and are found to start devastation of woodland and forestry prosperity in involvement with external managers who source them weapons and ammunition for unlawful logging and stealing. To stop the local tribal people from turning into offenders, the primary determination of the organizers should be to recompense for the damage to the residents by offering them employment chances.

The **Wayanad Wildlife Sanctuary** in Kerala has triggered dislocation of 53,472 tribal families. In the beginning, it was definite to allocate property to these tribal families in order to settle them. However, till 2003, only 843 families could get the land. As a consequence of this, the tribal people felt resentful, and in January, 2003, they intruded into the woodland in huge numbers, chopped the trees, started building huts and digging wells instigating a fierce meeting with the forestry administrators, eventually triggering damages and Jearhs to the people.

5.10 Rehabilitation Issues

The United Nations Universal Declaration on Human Rights [Article 25(1)] has declared that **right to housing is a basic human right**.

In our country, maximum of the dislocations has caused due to property attainment by the administration for numerous motives. For this reason, the administration has the Land Acquisition Act, 1894 which authorizes it to help sign to the individuals to evacuate their lands if there is a need as per administration development. Providing of money recompense in lieu of the property evacuated occurs in Section 16 of the Act. The main problems linked to dislocation and reintegration are as follows:

(a) Tribal people are typically the maximum impacted between the evacuated who are really underprivileged. Dislocation additionally upsurges their deficiency due to damage of property, home, careers, diet uncertainty, damage of admission to shared property assets, amplified illness and death, and societal remoteness.

(b) Breakup of families is a significant societal problem rising due to dislocation in which the women are the severely impacted and they are not even provided money or property recompense.

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(c) The tribal people are not accustomed with the marketplace rules and tendencies. Even if they get money recompense, they get isolated in the contemporary financial arrangement.

(d) The property attainment rules overlook the common possession of belongings, which is an integral structure between the tribal people. Therefore, the tribal people lose their communitarian basis of financial and social presence. They feel like fish out of water.

(e) Kinship systems, weddings, communal and social purposes, their folk songs, dances and events disappear with their dislocation. Even when they are relocated, it is an individual based relocation, which completely overlooks shared settlement.

(f) Damage of individuality and damage of the close connection between the individuals and the atmosphere is one of the major damages. The age-long native information, which has been inbred and practiced by them about the plants, animals, their usages, etc. gets misplaced.

Rehabilitation Policy

There is a need for a comprehensive National Rehabilitation Policy. Different states are following different practices in this regard.

Case Study – 4:

In case of **Sardar Sarovar Project**, Gujarat Administration is articulating its rule through numerous management determinations. It has stated that each landed outsee shall be permitted to allocation of irrigable land in the state which he picks for his relocation. The part of the property would be equivalent to that possessed by him previously and the least property given to an outsee would be 2 hectares. Though, there are difficulties of evicted outsees and those citizens who were farming forestry property. The cut-off date for recognizing an adult son in a family has not been fixed. It is significant since the adult son is to be treated as a separate family. The people of 20 submerged villages in Gujarat have been relocated at diverse places leading to breakdown combined relations.

The case of **Pong Dam** is different. The dam was built on Beas River in Himachal Pradesh in 1960, while it was a part of Punjab. The water is attached to irrigate Rajasthan. Rajasthan, thus, arranged to offer property to the outsees in the command part of Indira Gandhi Canal. Though, to carry Beas water to Rajasthan, additional dam had to be built adding 20,722 more relatives that were evacuated and had to be relocated by Rajasthan out of 30,000 families uprooted due to Pong dam, only they were bonafide cultivators for whom 2.25 lakh acre property was reserved. What happened to the rest of the 14,000 families is not answered. Punjab which is one of the receivers of the dam completely out of the reintegration problem. Only Rajasthan and Himachal Pradesh are trying to resolve the issue. Even those who have been resolved, they are in relocation locations in desert bordering Pakistan, more than thousand kilometers from their inherent residence, thus breaking their relationship bonds.

There is a necessity to increase community mindfulness on these problems to bring the relocation and reintegration strategies on a humanitarian stability and to honor the human privileges of the outsees.

Environmental Ethics – Issues and Possible Solutions

Environment morals mentions to the problems, moralities and rules connecting to human connections with their atmosphere. It is correctly said, *"The environmental crisis*

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is an outward manifestation of the crisis of mind and spirit". It all depends on how do we think and act. If we think *"Man is all powerful and the supreme creature on this earth and man is the master of nature and can harness it at his will",* it reflects our human-centric thinking. *On the other hand, if we think "Nature has provided us with all the resources for leading a beautiful life and she nourishes us like a mother, we should respect her and nurture her",* this is an earth-centric thinking.

The primary opinion needs us to march forward magnificently to overcome the nature and begin our sovereignty over nature through technical modernizations, financial development and expansion without caring for the harm done to the earth. The subsequent opinion needs us to live on this earth as a part of it, like any other creation of nature and live sustainably. So, we can see that our actions will trail what we contemplate. If we want to check the ecological disaster, we will have to alter our thoughts and perception. That would help in altering our actions, resulting in an improved atmosphere and improved future.

These two world-views are discussed here in relation to ecological defense:

1. **Anthropocentric Worldview:** This view is controlling most manufacturing civilizations. It puts man in the middle, giving him the uppermost rank. Man is well-thought-out to be very proficient for handling earth. The controlling ideologies of this view are:
   (a) Man is the earth's greatest significant class and is the in-charge of the rest of nature.
   (b) Earth has a limitless source of natural assets and it all belongs to us.
   (c) Financial development is very upright and additional progress will improve it further because that shall increase our superiority of lifestyle and the probability for financial development is infinite.
   (d) A hygienic atmosphere hinges upon a healthy economy.
   (e) The achievement of manhood hinges upon how virtuous administrators we are for originating profits for us from nature.
2. **Eco-centric Worldview:** This is grounded on earth wisdom. The elementary principles are as follows:
   (a) Nature exists not for man alone, but for all the breeds.
   (b) The earth resources are inadequate and they do not belong only to man.
   (c) Financial development is good till it inspires earth-sustaining advances and dejects earth-degrading change.
   (d) A healthy economy depends upon a healthy environment.
   (e) The success of mankind depends upon how best we can cooperate with the rest of the nature while trying to use the resources of nature for our benefit.

Environmental ethics can provide us the guidelines for putting our beliefs into action and help us decide what to do when faced with crucial situations. Some important ethical guidelines known as Earth ethics or Environmental Ethics are as follows:

1. You should love and honor the earth since it has blessed you with life and governs your survival.
2. You should keep each day sacred to earth and celebrate the turning of its seasons.
3. You should not hold yourself above other living things and have no right to drive them extinction.

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4. You should be grateful to the plants and animals which nourish you by giving you food.
5. You should limit your off-springs because too many people will overburden the earth.
6. You should not waste your resources on destructive weapons.
7. You should not run after gains at the cost of nature, rather should strive to restore its damaged majesty.
8. You should not conceal from others the effects you have caused by your actions on earth.
9. You should not steal from future generations their right to live in a clean and safe planet by impoverishing or polluting it.
10. You should consume the material goods in moderate amounts so that all may share the earth's precious treasure of resources.

If we critically go through the above ten commandments for earth ethics and reflect upon the same, we will find that various religions teach us the same things in one form or the other. Our Vedas have glorified each and every component of nature as gods or goddesses so that people have a feeling of reverence for them. Our religious and cultural rituals make us perform such actions that would help in the conservation of nature and natural resources. The concept of '*ahimsa*' (non-violence) in Buddhism and Jainism ensure the protection and conservation of all forms of life, thereby keeping the ecological balance of the earth intact. Our teachings on *"having fewer wants"* ensures to put "*limits to growth"* and thus, guide us to have an eco-centric lifestyle.

5.11 Climate Change

Climate is the average weather of an area. It is the general weather conditions, seasonal variations and extremes of weather in a region. Such conditions which average over a long period—at least 30 years is called climate.

The **Inter-governmental Panel on Climate Change (IPCC)** in 1990 and 1992 published best available evidence about past climate change, the greenhouse effect and recent changes in global temperature. It is observed that earth's temperature has changed considerably during the geological times. It has experienced several glacial and inter-glacial periods. However, during the past 10,000 years of the current interglacial period, the mean average temperature has fluctuated by 0.5-1^{o}C over 100- to 200-year period. We have relatively stable climate for thousands of years due to which we have practiced agriculture and increased in population. Even small changes in climatic conditions may disturb agriculture that would lead to migration of animals including humans.

Anthropogenic (man-made) actions are distressing the subtle equilibrium that has founded amongst numerous elements of the atmosphere. Greenhouse vapors are growing in the troposphere consequential in upsurge of the average global temperature. This may distress the hydrological cycle, cause inundations and famines in diverse areas of the world, sea level rise, variations in farming produce and demise of individuals as well as cattle.

The universal alteration in temperature will not be even all over the place and will vary in diverse areas. The places at higher latitudes will be warmed up more during late autumn and winter than the places in tropics. Poles may experience 2 to 3 times more warming than the global average, while warming in the tropics may be only 50% to 100% on an average. The amplified heating at poles will decrease the thermal gradient amongst the equator latitude and high latitude areas lessening the energy obtainable to

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the heat engine that drives the global weather machine will disrupt the universal outline of winds and ocean currents as well as the timing and circulation of rainwater. Shifting of ocean currents may change the climate of Iceland and Britain, and may result in cooling at a time when rest of the world warms. By a temperature increase of 1.5°C to 4.5°C, the global hydrological cycle is projected to increase by 5% to 10%. Distressed rainwater will cause few parts to become wetter and the others drier. Though precipitation might upsurge, higher temperatures will result in more evapotranspiration causing yearly water shortage in crop fields.

5.12 Nuclear Accidents and Holocaust

Nuclear mishaps can happen at any phase of the atomic fuel cycle. Though, the probability of device mishaps is observed very severely because the impacts of device mishaps are seriously extreme.

Numerous estimations of theoretical mishaps in an atomic power station are made. These estimations are made taking into contemplation numerous constraints like device security dealings, which if fail, would emit huge quantity of device stuffing, i.e., dangerous wreckages disturbing a considerable share of human people within a specific location in a specific zone.

The modern fusion bombs (nuclear bombs) are of the explosive force of 500 kilotons and 10 megatons. In case of a World War, total nuclear exchange of more than 5,000 megatons can be expected. Nuclear bombardment will cause combustion of wood, plastics, petroleum, forests, etc. Large quantity of black soot will be carried to the stratosphere. Black soot will absorb solar radiations and will not allow the radiations to reach the earth. Therefore, cooling will result. The ultraviolet energies which are re-radiated from the troposphere to the earth will have very few water vapors and carbon dioxide to soak them. If they leave the inferior troposphere, the greenhouse result will be troubled and freezing will arise. Due to this cooling effect, water evaporation will also reduce. Thus, ultraviolet energies soaking water vapors will decrease in the troposphere. In the stratosphere, there will not be substantial moistness to rain out the dense dust. Thus, because of atomic blasts, a phenomenon conflicting to global warming will arise. This is called **nuclear winter**. It may result in lower global temperature. Even the summer time will experience freezing temperature. It will severely impact crop harvest. Crop output will decrease considerably instigating scarcities and human sufferings.

The Chernobyl Nuclear Accident, 1986 has resulted in widespread contamination by radioactive substances (already mentioned in air pollution episodes). The devastation caused by nuclear bombs are not only immediate but may be long lasting. Towards, the end of World War II, bombing of Dresden, Germany caused huge firestorms. This caused particle laden updrafts in the atmosphere.

Case Study – 5:

In Nuclear holocaust in Japan 1945, two atomic missiles were released on Hiroshima and Nagasaki cities of Japan. One fission bomb was dropped on Hiroshima. This holocaust (large-scale destruction of human lives by fire) murdered approximately 100,000 people and demolished the town. This powerful blast released neutrons and gamma radiations. It had the force of 12 kilotons of trinitrotoluene (TNT). The radioactive strontium (Sr 90) liberated in the blast bears a resemblance to calcium and has the property of substituting calcium of the bones. As an outcome, large-scale bone deformities arose in the people of these metropolises. Even after more than 50 years, the effects of the atomic consequences are still evident.

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Wasteland Reclamation

Financially fruitless property facing ecological corrosion are known as wastelands. The wastelands include salt-affected lands, sandy areas, gullied areas, undulating uplands, barren hill-ridge, etc. Snow-covered areas, icy zones and parts reduced infertile after Jhum cultivation are also counted in wastelands. More than half of our country's topographical part (about 175 million ha) is projected to be wasteland, thus demonstrating the importance of the issue for a country like ours which has to support 1/6th of the world's population.

Extreme wasteland parts in our nation lie in Rajasthan (36 million ha) followed by Madhya Pradesh and Andhra Pradesh. In Haryana, the wastelands cover about 8.4% of the total land area and most of it includes salty, sodic or grimy terrestrial parts.

Wastelands are formed by natural processes, which consist of surging highlands, snow-clad land, seaside salty parts, grimy zones, etc. or by anthropogenic (man-made) activities leading to eroded, saline or waterlogged lands.

The foremost human caused actions causing in wasteland creation are desertification, overgrazing, mineral excavation and inaccurate farming practices. Although deserts are wastelands formed by natural process, there are many human activities which accelerate the spreading of desert as we have already discussed.

Wasteland Reclamation Practices

Wasteland repossession and growth in our nation falls under the view of **Wasteland Development Board**, which works to achieve the subsequent purposes:

- To expand the bodily construction and superiority of the bordering soils.
- To advance the obtainability of good quality water for irrigating these lands.
- To avert soil corrosion, inundating and landslips.
- To preserve the organic sources of energy of the terrestrial for maintainable usage.

Few significant repossession practices are discussed here.

(a) Land Development and Leaching: For repossession of the saline-impacted soil, it is essential to eliminate the salinities from the root zone which is typically attained by leakage, i.e., by putting additional quantity of water to push down the salts. After a study of the level of saltiness issue, soil texture, depth of resistant coating and water table, terrestrial smoothing is completed to ease well-organized and even application of water. After flattening and cultivating, the field is bunded in small plots and leakage is completed. In continuous leaching, 0.5 to 1.0 cm water is required to remove 90% of soluble salts from each cm of the soil depending upon texture. If we use recurrent sprinkling with 25 cm water, it reduces about 90% salinity in the upper 60 cm layer.

(b) Drainage: This is required for waterlogged soil reclamation where excess water is removed by artificial drainage.

(i) Surface Drainage: This is applied in parts where water stands on the fields after substantial showers by offering channels to overflow the surplus water. Usually, 30-45 cm deep itches lying parallel to each other at 20-60 m distance are able to remove 5 cm of water within 24 hours.

(ii) Sub-surface Drainage: Horizontal sub-surface discharge is offered in the state of pricked ridged PVC pipes or open-jointed pipes with a cover of stones 2-3 m below the land surface. Probabilities of disappearance of water resulting in gathering of salinities nearly turns zero in this

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technique. The World Bank has funded sub-surface discharge arrangement at Sampla, Rohtak (Haryana) for dropping soil saltiness by this technique.

(c) Irrigation Practices: Exterior irrigation with exact land flattening, polishing and well-organized hydraulic design benefit to decrease water logging and saltiness. High frequency irrigation with measured quantity of water aids to uphold improved water obtainability in the higher source region. Thin and recurrent irrigations have been found to be more beneficial for improved crop harvest when the irrigation water is salty as equated to some substantial irrigations.

(d) Selection of Tolerant Crops and Crop Rotations: Acceptance of crops to salts is found to vary from delicate, semi-tolerant, accepting to extremely accepting. Barley, sugar beet and date palm are extremely accepting crops which stay unaffected from any decrease in crop harvest even at severe saltiness with electric conduction (EC) of 10 ds/m. Wheat, sorghum, pearl millet, soyabean, mustard and coconut are salt-tolerant crops. Rice, millets, maize, pulses, sunflower, sugarcane and many vegetables like bottlegourd, brinjal, etc. are semi-tolerant. These diverse crop mixtures can be full-grown on salty muds.

(e) Gypsum Amendment: Alteration of sodic soils with gypsum is suggested for dropping soil sodic levels as calcium of gypsum substitutes sodium from the exchangeable sites.

(f) Green Manures, Fertilizers and Biofertilizers: Using of ranch plot compost or nitrogen manures have been found to progress salty muds. Green fertilizing with dhaincha (*Sesbania aculeata*), sunhemp or guar have also been testified to advance saline muds. Blue-green algae have been found to be quite promising as biofertilizers for refining salt-affected soils.

(g) Afforestation Programmes: The National Commission on Agriculture **(NCA)** presented numerous afforestation arrangements in the 6th Plan to cope up with the issue of scattering wasteland. The National Wasteland Development Board, in the Ministry of Environment and Forests, has set a target of bringing 5 million ha of wasteland annually under firewood and fodder plantation.

(h) Social Forestry Programmes: These programmes typically take in strip plantation on road, rail and canal sides, restoration of deprived forestry land, farm forestry, wasteland forest development, etc.

5.13 Consumerism and Waste Products

Consumerism refers to the consumption of resources by the people. While early human societies used to consume much less resources, with the dawn of industrial era, consumerism has shown an exponential rise. It has been related both to the increase in the population size as well as increase in our demands due to change in lifestyle. Earlier, we used to live a much simpler life and used to have fewer wants. In the modem society, our needs have multiplied and so consumerism of resources has also multiplied.

Our population was less than 1 million for thousands of years ever since we evolved on this earth. Today, we have crossed the 6 billion mark and are likely to reach 11 billion by 2045 as per World Bank estimates. Let us see how the changing population trends influence consumerism of natural resources and generation of wastes. Two types of conditions of population and consumerism exist.

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1. **People over Population:** It arises when there are extra individuals than obtainable provisions of diet, water and additional significant properties in the zone. Extreme inhabitants burden results in deprivation of the inadequate sources, and there is total deficiency, undernourishment and untimely demises. This arises in a smaller amount in advanced nations (LDCs). Here, due to huge number of individuals, satisfactory sources are not obtainable for everyone. So, there is less per individual usage though complete usage is severe.
2. **Consumption over Population:** This arises in the more advanced nations (MDCs). Here, inhabitants' number is lesser while sources are in plenty and because of expensive lifestyle per individual usage of sources is augmented. Extra the usage of sources, additional is the waste creation and bigger is the deprivation of the atmosphere.

   This concept can be explained by using the model of Paul Ehrlich and John Hodlren (1972):

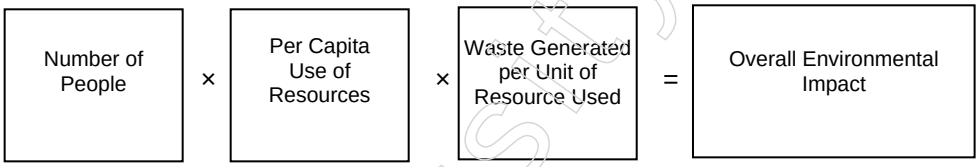

Fig. 5.3: Paul–John Model

In LDCs – Number of people is very high, but per capita use of resources and wastes generated are less.

In MDCs – Number of people is low, but per capita use of resources and wastes generated are very high.

The complete ecological effect of these two kinds of usages may be similar or even bigger in the situation of **MDCs.**

Thus, usages differ with each nation and USA is identified for extreme usage. The throwaway attitude and expensive lifestyle of the West results in severe resources being used up as compared to less advanced nations. With every unit of energy, inorganic substance or any reserve consumed, there is waste matter creation and contamination in the atmosphere.

A comparison of USA and India can illustrate this point more clearly.

Table 5.3: Comparison of Consumerism and Waste Generation

Parameter	% Global Values	
	USA	India
Population	4.7%	16%
Production of Goods	21%	1%
Energy Use	25%	3%
Pollutants/Wastes	25%	3%
CFC's Production	22%	0.7%

The table shows that although the population of India is 3.4 times more than that of USA, its overall energy use and waste generation are less than 1/8th that of USA. Thus, more consumerism leads to more waste production.

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Consumerism Highlights (Paul Ehrlich)

- On an average, a US citizen consumes 50 times as much as an Indian.
- A US born baby due to high consumerism will damage the planet earth 20-100 times more in a lifetime than a baby born in a poor family of LDC.
- A Japanese with a similar lifestyle as that of an American causes half the impact on environment. This is due to better technology. By adopting energy efficient and eco-friendly technologies and by following **'3R'** principle of Reduce, Reuse and Recycle, they have minimized the waste generated due to consumerism.

5.14 Environmental Legislation

India is the first country in the world to have made provisions for the protection and conservation of environment in its Constitution. On June 5, 1972, environment was first discussed as an item of international agenda in the **UN Conference on Human Environment** in Stockholm and thereafter **June 5** is celebrated **all over the world** as **World Environment Day**. Soon after the Stockholm Conference, our country took substantive legislative steps for environmental protection. The Wildlife (Protection) Act was passed in 1972, followed by the Water (Prevention and Control of Pollution) Act, 1974, the Forest (Conservation) Act, 1980, Air (Prevention and Control of Pollution) Act, 1981 and subsequently the Environment (Protection) Act, 1986.

Constitutional Provisions

The necessities for ecological defense in the Constitution were made within four years of Stockholm Conference, in 1976, through the 42nd amendment as follows:

Article 48-A of the Constitution provides: *"The state shall endeavour to protect and improve the environment and to safeguard forests and wildlife of the country."*

Article 51A(g) provides: *"It shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures."*

Thus, our Constitution contains ecological defense and preservation as one of our important responsibilities.

Few of the significant Acts passed by the Administration of India are discussed here.

Wildlife (Protection) Act, 1972

The Act is a milestone in the history of wildlife lawmaking in our nation, which came into presence in 1972. Wildlife was shifted from State list to concurrent list in 1976, thus giving power to the Central Government to ratify the lawmaking.

The **Indian Board of Wildlife (IBWL)** was formed in 1952 in our nation, which after the representation of the Wildlife (Protection) Act aggressively took up the task of setting up wildlife national parks and sanctuaries. The main events and necessities in the Act can be summed up as follows:

(a) It describes the wildlife-linked vocabulary.

(b) It offers for the selection of Wildlife Advisory Board, Wildlife Warden, their authorities, responsibilities, etc.

(c) Under the Act, complete citation of rare wildlife breeds was done for the first time and ban of shooting of the rare breeds was stated.

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(d) Defense to few rare floras such as Beddome Cycad, Blue Vanda, Ladies Slipper Orchid, Pitcher Plant, etc. is also offered under the Act,

(e) The Act offers for set up of national parks, wildlife sanctuaries, etc.

(f) The Act offers for the constitution of Central Zoo Authority.

(g) There is facility for occupation and business in few wildlife breeds with license for auction, ownership, handover, etc.

(h) The Act levies a prohibition on the occupation or business in listed faunas.

(i) It offers for lawful authorities to majors and penalty to criminals.

(j) It offers for imprisoned breeding programme for rare breeds.

Several conservation projects for individual endangered species like Lion (1972), Tiger (1973), Crocodile (1974) and Brown Antlered Deer (1981) were started under this Act. The Act is adopted by all states in India except Jammu & Kashmir, which has its own Act.

Few of the main disadvantages of the Act consist of little price to criminals, unlawful wildlife trade in Jammu & Kashmir, individual possession documentation for animal articles like tiger and leopard skins, no handling of distant rare wildlife, wretched state of wildlife in mobile zoos and little stress on defense of vegetal heritable properties.

Forest (Conservation) Act, 1980

This Act handles the preservation of woodlands and connected features. Except Jammu & Kashmir, the Act is accepted all over India. The Act protects under it all kinds of woodlands counting in earmarked woodlands, endangered woodlands or any woodland property regardless of its possession.

The noticeable structures of the Act are as follows:

(a) The State Government has been authorized under this Act to use the woodlands only for forestry purposes. If at all it wants to use it in any other way, it has to take preceding sanction of Central Government, after which it can permit guidelines for stating some portion of reserve forest for non-forest purposes (e.g., mining) or for chopping some naturally growing trees and substituting them by financially significant plants (reforestation).

(b) It makes facility for preservation of all kinds of woodlands, and for this, determination there is an Advisory Committee which mentions backing for it to the Central Government.

(c) Any unlawful non-forest action inside a woodland zone can be directly stopped under this Act.

Non-forest actions consist of clearance of woodland property for farming of any kind of floras/harvests or any additional determination (except reafforestation). Though, some building work in the woodland for wildlife or woodland managing is excused from non-forest action (e.g., fencing, making water holes, trench, pipelines, check pots, etc.).

1992 Amendment in the Forest Act

1. In 1992, few alterations were made in the Act which made requirements for permitting some non-forest actions in woodlands, without chopping trees or restricted chopping with preceding sanction of Central Government. These actions are setting of communication lines, seismic studies, examination, piercing and hydroelectric schemes. The last action includes large-scale

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devastation of woodland for which preceding sanction of the Centre is essential.

2. Wildlife preserves, national parks, etc. are completely forbidden for any examination or study under this Act without preceding sanction of Central Government even if no tree-felling is involved.
3. Cultivation of tea, coffee, spices, rubber and plants, which are cash crops, are included under non-forestry activity and not allowed in reserve forests.
4. Even cultivation of fruit-bearing trees, oil-yielding plants or plants of medicinal value in woodland zone need to be primarily permitted by the Central Government. This is because fresh presented breeds in the woodland part may reason in an inequity in the biology of the woodland. If the breeds to be implanted is a native breed, then no preceding permission is mandatory.
5. Tusser cultivation (a type of silk-yielding insect) in woodland parts by tribal people as a means of their livelihood is preserved as a forestry action as long as it does not include some precise host tree like Asan or Arjun. This is done in order to avert monoculture practices in the woodlands enriched in biodiversity.
6. Plantation of mulberry for rearing silkworm is considered a non-forest activity. The reason is same as described above.
7. Mining is a non-forestry action and preceding sanction of Central Government is obligatory. The Supreme Court in a case *T.N. Godavarinan Thirumulkpad v. Union of India* (1997) ordered all in process evacuation actions to be stopped instantly in any woodland part of India if it had not got preceding sanction of Central Government.
8. Removal of stones, bajri, boulder, etc. from riverbeds located within the forest area fall under non-forest activity.
9. Any proposal sent to Central Government for non-forest activity must have a cost-benefit analysis and Environmental Impact Statement (EIS) of the proposed activity with reference to its ecological and socio-economic impacts.

Thus, the Forests (Conservation) Act has made ample provisions for conservation and protection of forests and prevention of deforestation.

Water (Prevention and Control of Pollution) Act, 1974

It offers for preserving and reinstating the healthiness of water by averting and regulating its contamination. Contamination is explained as *such contamination of water, or such alteration of the physical, chemical or biological properties of water, or such discharge as is likely to cause a nuisance or render the water harmful or injurious to public health and safety or harmful for any other use or of aquatic plants and other organisms or animal life.*

The description of water contamination has therefore included the complete possible agents in water that may reason in any damage or have a possible destruction to any kind of life in any way.

The salient features and provisions of the Act are summed up as follows:

(a) It offers for conservation and renovation of quality of all kinds of exterior and groundwater.

(b) It offers for the, formation of Central and State Boards for contamination regulation.

(c) It discusses them with authorities and purposes to regulate contamination.

Notes

The Central and State Pollution Control Boards are extensively signified and are given complete authorities to counsel, organize and offer practical help for anticipation and regulation of contamination of water.

(d) The Act has provisions for funds, budgets, accounts and audit of the Central and State Pollution Control Boards.

(e) The Act makes provisions for numerous penalty prices for the non-payers and process for the same.

Central Pollution Control Board (CPCB)

The chief controlling bodies are the Pollution Control Boards which have been conferred the following duties and powers:

1. It counsels the Central Government in issues linked to stoppage and regulation of water contamination.
2. Organizes the events of State Pollution Control Boards and offers them practical aid and direction.
3. Arranges training agendas for stoppage and regulation of effluence.
4. Arranges complete plans on effluence linked problems through mass media.
5. Gathers, accumulates and issues practical and numerical statistics connected to contamination.
6. Makes guides for handling and discarding of manure and manufacturing sewages.
7. Lays down standards for water quality parameters.
8. Plans nation-wide programmes for prevention, control or abatement of pollution.
9. Establishes and recognizes laboratories for analysis of water, sewage or trade effluent sample.

The State Pollution Control Boards also have alike purposes to be performed at state level and are governed by the directions of **CPCB.**

- The Panel counsels the State Government with regards to the place of any business that might contaminate a river or a well.
- It lays down standards for sewages and is authorized to take examples from any river, well or manufacturing waste or manure passing through an industry.
- The State Board is authorized to take lawful examples of manufacturing sewage in agreement with the process laid down in the Act. The example reserved in the existence of the occupier or his agent is separated into two parts, closed, signed by both parties and sent for experts to some known labs. if the samples do not obey to the set water quality standards (crossing maximum permissible limits), then 'consent' is refused to the unit.
- Every business has to gain agreement from the Board (granted for a fixed duration) by applying on an agreed Proforma listing all practical facts, along with a prescribed payment following which examination of the waste is approved.
- The Panel proposes well-organized approaches for consumption, handling and discarding of manufacturing sewages.

The Act has made thorough requirements concerning the power of the Boards to gain data, take manufacturing examples, limit newfangled openings, limit growth, passage, and review the units and permission or deny agreement to the business after waste examination.

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Notes

While growth is essential, it is all the more significant to stop contamination, which can risk the lives of the people. Fitting and correct working of waste handling plants in all contaminating businesses is a must for checking contamination of water and land. Despite certain weaknesses in the Act, the Water Act has plenty requirements for averting and regulating water contamination through lawful actions.

The Air (Prevention and Control of Pollution) Act, 1981

Noticeable structures of the Act are as follows:

(a) The Act offers for stoppage, regulation and reduction of air contamination.

(b) In the Act, *air pollution has been defined as the presence of any solid, liquid or gaseous substance (including noise) in the atmosphere in such concentration as may be or tend to be harmful to human beings or any other living creatures or plants or property or environment.*

(c) Noise contamination has been introduced as contamination in the Act in 1987.

(d) Pollution Control Boards at the central or state level have the controlling authority to implement the Air Act. Just parallel to the purposes linked to Water (Prevention and Control of Pollution) Act, the Boards performs alike roles linked to development of air quality. The Boards have to check whether or not the business severely obeys the standards. or standards laid down by the Board under Section 17, concerning the release or discharge of any air contaminant. Grounded upon examination statement permission is approved or rejected to the business.

(e) Just like the Water Act, the Air Act has provisions for stating the composition, authorities and roles of Pollution Control Boards, funds, accounts, audit, penalties and procedures.

(f) Section 20 of the Act has provision for safeguarding release standards from vehicles. Grounded upon it, the State Government is authorized to issue training to the expert in-charge of registering of motor vehicles (under Motor Vehicles Act, 1939) that is tied to obey with such orders.

(g) As per Section 19, in conference with the State Pollution Control Board, the State Government might announce a zone inside the state as **"air pollution control area"** and can forbid the usage of any fuel other than permitted fuel in the area instigating air contamination. No person shall, without preceding agreement of State Board, operate or establish any industrial unit in the "air pollution control area".

The Water and Air Acts have also made superior provisions for appeals. Under Section 28 of Water Act and Section 31 of Air Act, a provision for appeals has been made. An **Appellate Authority** consisting of a single person or three persons appointed by the Head of the State, Governor is constituted to hear such appeals as filed by some aggrieved party (industry) due to some order made by the State Board within 30 days of passing the orders.

The Appellate Authority, after giving the appellant and the State Board an opportunity of being heard, disposes off the appeal as expeditiously as possible.

The Environment (Protection) Act, 1986

The Act came into force on November 19, 1986, the birth anniversary of our Late Prime Minister Indira Gandhi, who was a creator of ecological defense problems in our nation. The Act extends to whole of India. Some terms related to environment have been described as follows in the Act:

Notes

(a) Environment includes water, air and land and the interrelationships that exist among and between them and human beings, all other living organisms and property.

(b) Environmental Pollution means the presence of any solid, liquid or gaseous substance present in such concentration, as may be, or tend to be, injurious to environment.

(c) Dangerous Element means any constituent or grounding which by its physio-chemical possessions or treatment is accountable to reason in damage to human beings, other living creatures, assets or atmosphere.

The Act has given powers to the Central Government to take actions to defend and advance atmosphere while the State Governments organize the activities. The most important functions of Central Government under this Act include setting up of:

- The standards of quality of ail, water or soil for various areas and purposes.
- The extreme allowable restrictions of absorption of numerous ecological contaminants (including noise) for diverse parts.
- The proceedings and protections for the treatment of dangerous elements.
- The ban and limitations on the treatment of dangerous elements in dissimilar zones.
- The ban and limit on the site of businesses and to carry on procedure and acts in diverse parts.
- The measures and protections for the stoppage of mishaps which may cause ecological contamination and providing for corrective actions for such mishaps.

The power of entry and inspection, power to take sample, etc. under this Act lies with the Central Government or any officer empowered by it.

For the determination of shielding and refining the superiority of the atmosphere and averting and narrowing contamination norms have been stated under Schedule I-IV of Environment (Protection) Rules, 1986. These standards vary from business to business and also differ with the medium into which the sewage is discharged or the part of release. For example, the extreme allowable restrictions of BOD (Biochemical Oxygen Demand) of the waste water is 30 ppm if it is cleared into inland waters, 350 ppm if cleared into a public sewer and 100 ppm, if it is cleared into terrestrial or seaside area. Similarly, release standards vary in housing, delicate and manufacturing zone. Naturally, the standards for delicate zones like hospitals are more severe. It is the responsibility of the Pollution Control Board to check whether the businesses are obeying the set standards or not.

Under the **Environmental (Protection) Rules, 1986**, the State Pollution Control Boards have to follow the guidelines provided under Schedule VI, some of which are as follows:

(a) They have to counsel the businesses for treating the waste water and gases with the finest obtainable technology to attain the set norms.

(b) The businesses have to be motivated for reprocessing and recycling the waste matters.

(c) They have to boost the businesses for retrieval of biogas, energy and recyclable resources.

(d) While allowing the release of wastes and releases into the atmosphere, the State Boards have to take into account the assimilating ability of the receiving water body.

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(e) The Central and State Boards have to highlight on the application of hygienic machineries by the businesses in order to upsurge fuel competence and decrease the generation of ecological contaminants.

Under the Environment (Protection) Rules, 1986, an amendment was made in 1994 for Environmental Impact Assessment (EIA) of various growth schemes. There are 29 types of projects listed under Schedule I of the rule which need permission from the Central Government before establishing.

Others need permission from the State Pollution Control Board, when the planned scheme or growth action is going to reason in contamination load surpassing the present stages. The project proponent has to provide EIA report, risk analysis report, NOC from State Pollution Control Board, Commitment regarding availability of water and electricity, summary of project report/feasibility report, filled in a survey for ecological assessment of the scheme and complete reintegration strategy, if more than 1000 people are likely to be displaced due to the project.

Under the Environment (Protection) Act, 1986, the Central Government also made the Hazardous Wastes (Management and Handling) Rules, 1989. Under these rules, it is the accountability of the occupier to take all applied measures to safeguard that such waste matters are correctly treated and discarded without any opposing impacts. There are 18 Dangerous Waste groups documented under this law and there are strategies for their correct treatment, storing, dealing, transportation and discarding which should be severely followed by the owner.

The Environment (Protection) Act, 1986 has also made provision for Environmental Audit as a means of checking whether or not a business is obeying with the ecological commandments and rules. Therefore, plenty provisions have been made in our country through commandment for refining the quality of our atmosphere.

Enforcement of Environmental Legislation – Major Issues

We have seen that there are a number of important environmental laws in the form of Acts for safeguarding our environmental quality. But despite of these Acts, we find that we are not able to achieve the target of bringing 33% of our land cover under forests. Still we are losing our wildlife. The rivers have been fumed into open sewers in many places and the air in our big cities is badly polluted. The status of environment shows that there are drawbacks in environmental legislations and problems in their effective implementation.

Let us examine some important issues related to our Acts:

(a) Drawbacks of the Wildlife (Protection) Act, (1972)

(i) It seems as if the Act has been enacted just as a fallout of Stockholm Conference held in 1972 and it has not included any locally evolved conservation measures.

(ii) The ownership certificates for animal articles (tiger, leopard skins, etc.) are permissible which very often serve as a tool for illegal trading.

(iii) The wildlife traders in Jammu & Kashmir easily get illegal furs and skins from other states which after making caps, belts, etc. are sold or smuggled to other countries. This is so happening because J & K has its own Wildlife Act and it does not follow the Central Wildlife Act. Moreover, hunting and trading of several endangered species prohibited in other states are allowed in J & K, thereby opening avenues for illegal trading in such animals and articles.

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(iv) The offender of the Act is not subject to very harsh penalties. It is just up to 3 years imprisonment or a fine of ₹ 25,000 or both.

(b) Drawbacks of the Forest (Conservation) Act, 1980: This Act has inherited the exploitative and consumerist elements from the Forest laws of British period. It has just transferred the powers from State to Centre to decide the conversion of reserve forest lands to non-forest areas. Thus, power has been centralized at the top. At the same time, the local communities have been completely kept out from the decision-making process regarding the nature of use of forest area. Very often, the tribal people who lived in the forest and were totally dependent on forests retaliate when stopped from taking any resources from there and start criminal activities including smuggling, killing, etc. The Act has failed to attract public support because it has infringed upon the human rights of the poor native people. They argue that the law is concerned about protecting the trees, birds and animals, but is treating the poor people as marginal. *Very poor community participation in the Act remains one of the major drawbacks which affect proper execution of the Act.* The forest-dwelling tribal communities have a rich knowledge about the forest resources, their importance and conservation. But their role and contribution is neither acknowledged nor honored.

Efforts are now being made to make up for the gaps in laws by introducing the principles of Public Trust or Human Rights Protection.

Drawbacks of Pollution Related Acts

1. The power and authority have been given to Central Government with little delegation of power to State Government. Excessive centralization very often hinders efficient execution of the provisions of the Acts in the states. Illegal mining is taking place in many forest areas. In Rajasthan alone, about 14,000 cases of illegal mining have been reported. It becomes more difficult to check such activities at the central level. The provision of penalties in the Act is very insignificant as compared to the damage caused by the big industries due to pollution. The penalty is much less than the cost of the treatment/pollution control equipment. This always gives a loose rope to the industries.
2. The Act has not included the “right to information” for the citizens. This greatly restricts the involvement or participation of the general public. The Environment (Protection) Act, 1986 regarded as an umbrella Act, encompassing the earlier two Acts often seems superfluous due to overlapping areas of jurisdiction. For instance, Section 24(2) of the new Act has made a provision that if the offender is punishable under the other Acts like Water Act or Air Act also, then he may be considered under their provisions. Interestingly, the penalty under the older two Acts is much lighter than the new Act. So, the offender easily gets away with a lighter punishment. Under Section 19, a person cannot directly file a petition in the court on a question of environment and has to give a notice of minimum 60 days to the Central Government. In case no action is taken by the latter, then alone the person can file a petition which certainly delays the remedial action.
3. Litigation, particularly related to environment is very expensive, tedious and difficult since it involves expert testimony, technical knowledge of the issues and terminologies, technical understanding of the unit process, lengthy prosecutions, etc. The State Boards very often lack adequate funds and expertise to pursue their objectives. A tendency to seek to exercise gentle

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pressure on the polluter and out of the court settlements usually hinder the implementation of legal measures.

4. For small units, it is very expensive to install Effluent Treatment Plant (ETP) or Air Pollution control devices and sometimes they have no other option but to close the unit. The Act should make some provision for providing subsidies for installing treatment plants or common effluent treatment plants for several small units.
5. The pollution control laws are not backed by sound policy pronouncements or guiding principles.
6. The position of chairman of the Boards is usually occupied by political appointee. Hence, it is difficult to keep political interference at bay.
7. The policy statement of the Ministry of Environment and Forests (1992) of involving public in decision-making and facilitating public monitoring of environmental issues has mostly remained on paper.
8. Environmental policies and laws need to be aimed at democratic decentralization of power, community-state partnership, administrative transparency and accountability, and more stringent penalties to the offender. There is also a need for environmental law education and capacity building in environmental issues for managers.

5.15 Public Environmental Awareness

Civic mindfulness about atmosphere is at a stage of infancy. Of late, some awareness has taken place related to ecological deprivation, contamination, etc., but inadequate information and data, and unawareness about many aspects has often led to misconceptions.

Growth has paved the path for rise in the levels of standards of living, but it has simultaneously led to serious ecological tragedies. Issues related to environment have often been branded as anti-development. The wisdom lies in maintaining a balance between our needs and supplies so that the delicate environmental equilibrium is not disturbed.

Some of the main reasons responsible for widespread environmental ignorance can be summed up as follows:

(a) Our courses in science, technology, economics, etc. have so far failed to integrate the knowledge in environmental aspects as an essential component of the curriculum.

(b) Our planners, decision-makers, politicians and administrators have not been trained so as to consider the environmental aspects associated with their plans.

(c) In a zeal to go ahead with some ambitious development projects, quite often there is purposeful concealment of information about environmental aspects.

(d) There is greater consideration of economic gains and issues related to eliminating poverty by providing employment that overshadows the basic environmental issues.

Methods to Propagate Environmental Awareness

Ecological mindfulness needs to be formed through formal and informal education to all sections of the society. Everyone needs to understand it because ‘environment belongs to all and every individual matters’ when it comes to conservation and protection of environment.

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Numerous phases and approaches that can be useful for rising ecological mindfulness in diverse segments of the society are as follows:

(a) Among Students through Education: Ecological teaching must be informed to the school children right from the childhood stage. It is a welcome step that now all over the country we are presenting ecological lessons as a subject at all stages including school and college level, following the directives of the Supreme Court.

(b) Among the Masses through Mass Media: Media can play an important role to educate the masses on environmental issues through articles, environmental rallies, plantation campaigns, street plays, real eco-disaster stories and success stories of conservation efforts. TV serials like Race to Save the Planet, Captain Planet, etc have been effective in propagating environmental awareness among the viewers.

(c) Among the Planners, Decision-makers and Leaders: Since this elite section of the society plays the most important role in shaping the future of the society, it is very important to give them the necessary orientation and training through specially organized workshops and training programmes.

Publication of environment-related resource material in the form of pamphlets or booklets published by Ministry of Environment and Forests can also help in keeping this section abreast of the latest developments in the field.

Role of Non-Government Organizations (NGOs)

Voluntary organizations can help by advising the government about some local ecological problems, and at the same time, interacting at the grass-root levels. They can act as an actual and feasible connection amongst the two. They can act both as an **'action group'** or a **'pressure group'**. They can be very effective in organizing public movements for the protection of environment through creation of awareness.

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Fig. 5.4: Tree plantation campaigns serve as the most effective environmental conservation efforts involving local people. Shri. Sunderlal Bahuguna, the Chipko Movement leader, planting a sapling

The **"Chipko Movement"** for conservation of trees by Dasholi Gram Swarajya Mandal, Gopeshwar or the "Narmada Bachao Andolan" organized by Kalpavriksh are some of the instances where NGOs have played a landmark role in the society for conservation of environment.

The **Bombay Natural History Society (BNHS), the Worldwide Fund for Nature – India (WWF, India) Kerala Sastra Sahitya Parishad, Centre for Science and Environment (CSE)** and many others are playing an important part in making ecological mindfulness through research as well as extension work. The recent report by CSE on more than allowable restrictions of insecticides in the cola drinks sensitized the people all over the country.

Before we can all take up the task of ecological defense and preservation, we have to be ecologically refined and conscious. It is aptly said *"If you want to act green, first think green."*

5.16 Summary

Development conventionally means economic well-being of community and country. But development is more than income levels. Maintainable growth means expansion that fulfills the wants of the current inhabitants without negotiating the capability of upcoming generations to fulfill their individual wants. The main problems are energy, preservation, ecologies and water. In Indian context, we have to hinge on

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well-thought strategies for our progressive actions and simultaneously growing our monetary progress. India is the first nation in the world to have made requirements for defense of atmosphere in the constitution. There are more than two hundred legislations for protection of environment.

5.17 Check Your Progress

I. Multiple Choice Questions

1. The Air (Prevention and Control of Pollution) Act was approved in _____.
   (a) 1971
   (b) 1951
   (c) 1981
   (d) 1961
2. The Environment (Protection) Act came into action in _____.
   (a) 1976
   (b) 1986
   (c) 1996
   (d) 2001
3. _____ has the power to give order to close the industry to the concerned officer, if such industry is responsible for Air Pollution.
   (a) Collector
   (b) Tahsildar
   (c) Board of State Pollution Control
   (d) Head of District Police
4. To give the order to close down, the factory responsible for pollution is the power of _____.
   (a) Board of State Ministers
   (b) Board of State Pollution Control
   (c) State Transport Corporation
   (d) Chief Minister
5. The object of Wildlife Act, 1972 is _____.
   (a) To count the wildlife
   (b) To collect information about wildlife
   (c) To provide medicine to the wildlife
   (d) To protect the wildlife

5.18 Questions and Exercises

1. What do you understand by sustainable development?
2. What is rainwater harvesting to conservation of water?
3. Write short notes on:
   (a) Global Warming
   (b) Greenhouse Gases
   (c) Acid Rain
   (d) Nuclear Holocaust

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4. Explain the prominent structures of Environment Protection Act, 1986.
5. What is the need for Water Act of 1974? Explain.

5.19 Key Terms

- **Climate:** Long-term pattern of weather in a particular area.
- **Ethics:** The moral values and principles.
- **GNP:** Gross National Product and index for country's economic development.
- **Ground Water:** Water held in aquifers (basins) below the earth's surface.
- **Nuclear Fusion:** Two nuclei of isotopes of lighter elements fused to form a heavier nucleus.
- **Urbanization:** Increasing concentration of population in cities.
- **WHO:** World Health Organization.

5.20 Check Your Progress: Answers

I. Multiple Choice Questions

Question	Answer
1	(c)
2	(b)
3	(c)
4	(b)
5	(d)

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Unit VI: Human Population and the Environment

Structure:

Objectives

After studying this unit, you should be able to:

- Understand the importance of family welfare programme and their relationship between environment, population and human health
- Define the importance of value education with reference to human rights, women, and child welfare
- Explain the role of information technology in environment
- Describe the killer diseases such as HIV and AIDS

6.1 Introduction

Population Growth and Variations among Nations

Our global human population 7 billion at present, will cross the 7 billion mark by 2015. The wants of this massive sum of inhabitants fails to be maintained by the Earth's natural sources of energy, without deteriorating the standards of human beings.

In coming years, remnant fuel from oil fields will exhaust. It will fail to fulfill the requirements for diet from prevailing agro-systems. Meadowlands will be grazed extremely by livestock and manufacturing development will generate bigger issues because of the contamination of soil, water and air. The oceans will not have sufficient fish. Bigger ozone holes will grow because of the release of manufacturing toxins into the environment, which will disturb well-being of the human beings. Global warming because of manufacturing vapors will result in a rise of the oceanic heights and inundations in all the lowland parts, immersing seaside farming, townships and metropolises as well. Water scarcities because of the exhaustion of hygienic water will generate disturbance and ultimately result in wars amongst nations. The regulation over

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local organic variety, which is crucial for creating remedial and manufacturing goods, will result in severe financial battles between bio-technologically progressive countries and the bio-enriched nations. The deprivation of ecologies will result in loss of thousands of breeds, threatening organic ecologies of immense worth. These are only few of the ecological difficulties linked to growing inhabitants and more exhaustive usage of sources that we are probable to experience in the coming years. These impacts can be prevented by making a massive ecological mindfulness drive that will bring a modification in the lifestyles of human beings.

Upsurge in per capita manufacture of farming harvest at an international stage stopped at the time of 1980s. In few nations, food scarcity has become an everlasting issue. Two of every three kids in South Africa are malnourished. In other areas, scarcities because of famines have become very recurrent. The recent expansion plans have failed to effectively discourse these difficulties linked to starvation and undernourishment. On the flip side, only 15% of the world's inhabitants in the advanced world is earning 79% of income. Therefore, the difference in the level of per capita sources that are consumed by individuals who live in an advanced nation as in contradiction of those who live in an emerging nation is very huge. Likewise, the difference amongst the wealthy and the underprivileged in India is also rising.

The growing burdens on sources put an excessive strain on the natural shielding act of the environment that has a particular capability to preserve an equilibrium in our atmosphere. However, recent growth policies have caused a collapse of our Earth's capability to restock the supplies which we hinge on.

Global Population Growth

The world populace is rising by more than 90 million per year, of which 93% is in emerging nations. This will fundamentally avert their additional financial growth. Current forecasts display that if our inhabitant's development is regulated, it will still continue to rise by 7.27 billion by 2015. But, if zero steps are undertaken, it will reach 7.92 billion.

Human populace evolution amplified from:

1 to 2 billion, in 123 years.

2 to 3 billion, in 33 years.

3 to 4 billion, in 14 years.

4 to 5 billion, in 13 years.

5 to 6 billion, in 11 years.

It is not the survey statistics alone that need to be strained, but an appreciation of this effect on our organic sources of energy. The degree of this exhaustion is additionally amplified by wealthy communities that use per capita more sources of energy than underprivileged individuals. This is of massive significance for evolving a newfangled idea for a reasonable circulation of energy supplies.

In the primary phase of the 1900s, human population was rising quickly in most emerging nations like India and China. In few African nations, the development was also noteworthy. In contradiction, the advanced nations' inhabitant's development had decelerated. It was stated that the worldwide development percentage was reducing the Earth's natural supplies of energy and was a straight obstruction to human growth. Numerous ecological impacts were connected with the growing populace of the emerging nations. Deficiency mitigation agendas were unsuccessful. It was never sufficient as a massive number of individuals had to be maintained on Earth's inadequate energy sources. In countryside parts, populace development has caused amplified disintegration of woodlands and joblessness. In the city area, it has caused

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insufficient housing and a growing amount of air contamination from road traffic, water contamination from dirt, and an incapability to deal with hard waste matter. By the 1970s, maximum nations in the emerging world had realized that if they had to grow their financial prudence and advance the lifestyles of their people, they would have to limit populace development.

Nevertheless, populace evolution displays an overall worldwide deterioration. There are differences in the percentage of deterioration in diverse nations. By the 1990s, the development percentage was declining in maximum nations like China and India. The deterioration in the 90s was highest in India. However, fertility remains excessive in sub-Saharan African nations.

There are social, financial, party-political and demographic motives that clarify the alterations in the percentage of populace regulation in diverse nations. It also differs in dissimilar regions of particular nations and is connected with communal and/or spiritual thoughts. The absence of administration strategies for Family Welfare Programme (FWP) and restricted admission to a complete variety of preventive steps are few of the severe obstacles to restraining populace development in numerous nations.

Population Control

In reply to our remarkable populace development, India undertook an operative Family Planning Programme, which was retitled the Family Welfare Programme. Slogan such as *'Hum do hamare do'* specified that every household must not have more than two kids. Still, it took numerous years to turn very efficient.

At the international stage, by the year 2000, 600 million or 57% of females in the generative phase were making use of few techniques of contraception. But, the usage of preventive steps is amplified in advanced nations – 68% and lesser in emerging nations – 55%. Woman purification is a very famous way of contraception applied in emerging nations at present day. This is trailed by usage of Oral Contraceptive Pills and Intra Uterine Devices (IUDs) for females and the usage of condoms for men. India and China have been using everlasting purification excessively than any other nation in the emerging phase.

The finest conclusion for the technique to be applied by a pair must be grounded on decent guidance from doctors or qualified communal employees who can advise the complete choices of approaches accessible for them to select from.

Updating the community about the numerous preventive steps that are obtainable is of main significance. This must be done dynamically by Government Agencies such as Health and Family Welfare, as well as Education and Extension workers. It is of immense significance for policy-makers and chosen governments of the individuals – Ministers, MPs, MLAs at the central and state levels – to comprehend the excessive and imperative necessity to encourage the FWP. The mass media must keep individuals knowledgeable about the necessity to restrict family size and the bad impacts of a rising inhabitants on the world's sources of energy.

The choice to restrict family size hinges on a pair's family background and schooling. This is connected to Government Policy, the efficiency of FWPs, the informative stages and statistical points in mass communication. The permitted admission to Family Welfare data provided by the health care system is, in few situations, inappropriately countered by social arrogances. Often, misrepresentation and insufficient data are causes as to why a family does not go in for restricting its size.

The biggest task the world today experiences is how to source its increasing human populace with the supplies it demands. As the inhabitants grow more, water scarcities will become severe. The soil will become fruitless. The streams, ponds and

seaside waters will be progressively contaminated. Water associated sicknesses today kill about 12 million individuals annually in the emerging nations. By 2025, there will be 48 nations that are hungry for water. Air will turn highly contaminated; air contamination today kills nearly 3 million individuals annually.

The first 'green revolution' in the 1960s harvested a huge quantity of food, but has caused numerous ecological difficulties. Today, a newfangled green revolution is required, to offer sufficient diet for our rising populace that will not harm property, kill streams by constructing big dams, or spread at the price of significant woodlands, plains and swamplands.

The world's greatest populated areas are the seaside parts. These are vital ecologies and are being quickly devastated. Universal weather alteration is today a danger that can distress the existence of thickly inhabited seaside people. In the sea, fishes are affected from extreme fishing. Once measured as an infinite reserve, over-fishing has exhausted stocks very speedily. It will become unbearable to sustain additional development in seaside populaces on the current fish resources.

Rising human inhabitants will unavoidably increase from woodlands into the outstanding inline woodlands. Numerous such infringements in India have been normalized in the past few years. But woodland damage has long-standing bad impacts on water and air standards. Inappropriately, the damage of biodiversity is usually not observed as a big warning to welfare of human beings.

Energy usage is rising, because of a growing populace and a lifestyle that progressively makes use of consumer products which need big quantities of energy for their manufacture, wrapping and transportation. Our rising populace increases the massive quantity of waste matter.

With all these connections amongst populace development and the atmosphere, FWPs have become crucial for survival of human beings.

Planning for the Future

How administrations and individuals from each communal group fulfil tasks like restricting populace size, shielding the organic atmosphere, altering consumer-oriented arrogances, dropping customs that generate extreme waste matter, lessening deficiency, and making an operative equilibrium amongst preservation and growth will control the future.

6.2 Population Growth

In 1800, the earth was home to about 1 billion people. The dramatic way in which global human population grew thereafter is shown in Fig. 7.1. It took about thirty-nine thousand years of human history to reach 1 billion, 130 years to reach the second billion, 45 years to reach 4 billion and the next doubling is likely within a span of a few decades. We have already crossed 6 billion and may reach 11 billion by 2045 as per the World Bank estimates.

(c) Amity University Online

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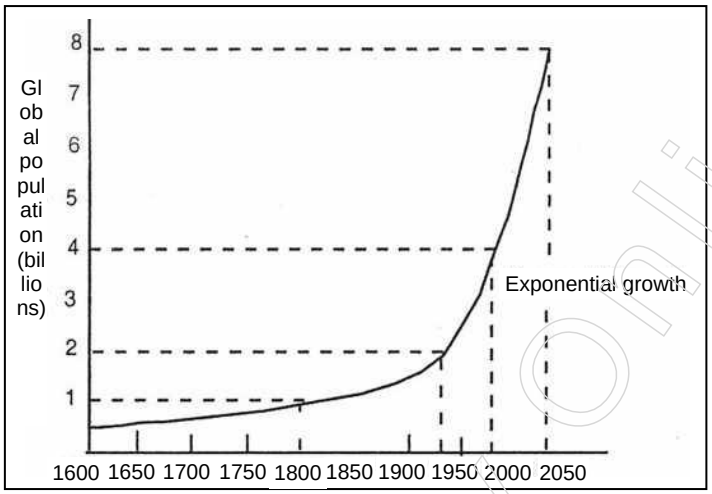

Fig. 6.1: Global Population Growth Trends in the Last Four Centuries

Let us look at the reasons of this trend of human population growth. In the beginning of human civilization, during the Stone Age, population was quite stable. Environmental conditions were hostile and humans had not yet developed adequate artificial means for adaptations to these stresses. Droughts and outbreak of diseases used to be quite common leading to mass deaths. The 14th century A.D. demonstrated an extensive death rate because of Bubonic plague when about 50% of individuals in Asia and Europe deceased because of the illness.

With scientific and technological advancement, life expectancy of humans improved. People started living in definite settlements leading a more stable life with better sanitation, food and medical facilities. Victory over famine-related deaths and infant mortality became instrumental for a rapid increase in population size. In agriculture-based societies, children were considered as economic assets who would help the parents in the fields.

6.3 Population Characteristics and Variations among Nations

Exponential Growth: When a number upsurges by a continuous amount per unit time, e.g., 1, 3, 5, 7, etc., it is termed as Lined Development. But when it upsurges by a secure proportion, it is identified as Exponential Growth, e.g., 10, 102, 103, 104, or 2, 4, 8, 16, 32, etc. Populace development occurs exponentially and that clarifies the affected upsurge in worldwide inhabitants in the last 150 years.

Doubling Time: The period required for a populace to duple its size at a continuous yearly percentage is identified as doubling up time. It is calculated as follows:

$$Td = 70/r$$

where, Td = Doubling time in years

r = Annual growth rate

If a nation has 2% annual growth rate, its population will double in 35 years.

Total Fertility Rates (TFR): It is one of the important steps of a country's populace development. TFR is defined as the average number of children that would be born to a woman in her lifetime if the age specific birth rates remain constant. The value of TFR varies from 1.9 in developed nations to 4.7 in developing nations. In 1950s, the TFR has been 6.1. Though, because of variations in social and technical set-up of cultures and administration strategies, the TFR has come down which is a wanted alteration.

Infant Mortality Rate: It is an imperative constraint distressing upcoming development of a populace. It is the ratio of babies deceased out of those born in a year. Though this proportion has degenerated in the past 5 decades, but the outline varies extensively in advanced and emerging nations.

Replacement Level: This is a significant idea in populace changing aspects or anthropology. Two parents bearing two children will be substituted by their children. But, because of newborn death, this substitute stage is typically altered. For emerging countries, where newborn deaths are excessive and life expectancy is less, the spare stage is approximately 2.7, while in advanced countries, it is 2.1.

Age Structure: Age construction of populace of a country can be signified by age pyramids, grounded upon individuals fitting into diverse age groups like pre-reproductive (0-14 years), reproductive (15-44 years) and post-reproductive (45 years and above).

We get three types of age pyramids:

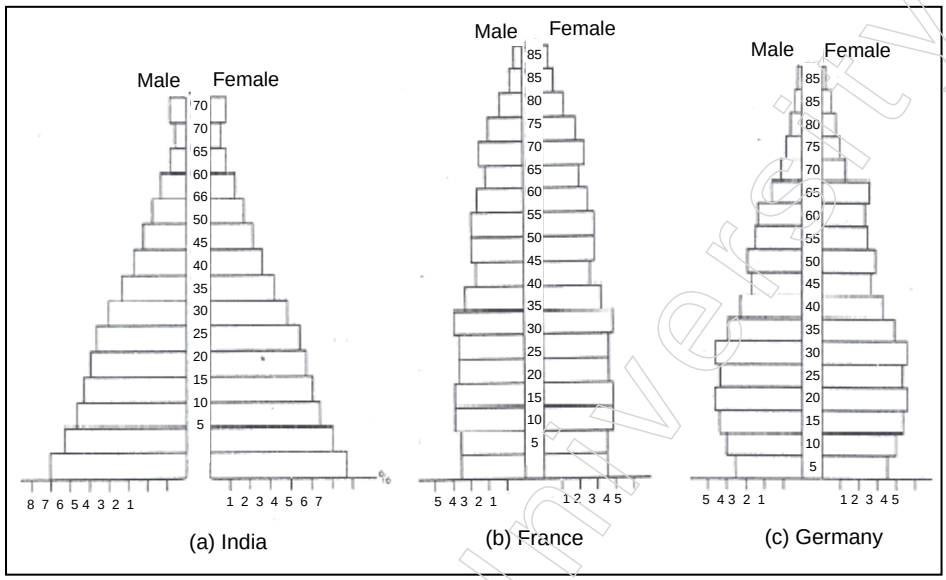

Fig. 6.2: Age Pyramids: (a) Pyramids Shaped Expanding Population – India, (b) Bell-shaped Stable Population – France, (c) Urn-shaped Declining Population – Germany

(Source: UN Demography Year Book, 2000)

(a) Pyramid-shaped: Here, the very young population is more, making a broad base and old people are less. This type indicates growing population. India, Bangladesh, Ethiopia and Nigeria are examples of this type. The vast sum of people in very young age will soon enter into reproductive age, thus causing an increase in population, whereas a smaller number of people in old age indicates less loss of population due to death.

(b) Bell-shaped: It occurs in countries like France, USA and Canada where birth rates have in the past one or two decades declined resulting in people of almost equal number in age group 0-35 years. So, in the approaching decade, the people entering into reproductive age group is not going to change much and such age pyramids indicate stable populations.

(c) Urn-shaped: Here, sum of people in very young class is smaller than the middle reproductive age class. In the approaching decade, the number in reproductive age class will thus become less than before resulting in a decline

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of population growth. Germany, Italy, Hungary, Sweden and Japan are examples of this type.

The TFR, age structure, infant mortality and replacement level are all important parameters determining population growth. But population will not stop growing even when all couples have only two children.

Case Studies

- Ethiopia is a developing nation with a pyramid-shaped age structure indicating expanding population. Its TFR is 6.9 presently. Even, if it aims to reach the replacement level by the year 2050, its population that is 57 million now might increase to 225 million by 2050 when TFR becomes 2.1 and remain rising till it stages off, 10 decades later, at 370 million.
- Population growth is also affected due to AIDS in the HIV-prevalent countries mainly in Africa. The earlier population projections of UN are now found to be reduced by 8% in the seriously HIV-affected countries, i.e., Mali, Rwanda, Uganda and Zambia. In Zimbabwe, HIV affects a quarter of the population aged between 15-49 years. In Botswana, 2/3rd of the 15-year old are predicted to die of AIDS before reaching 50 years of age. About 30% of adult population in many African countries is HIV-positive. This has drastically reduced life expectancy in these countries.

Zero Population Growth (ZPG): When birth plus migration in a populace are just equivalent to demises plus relocation, it is said to be nil populace development.

Male-Female Ratio: The ratio of boys and girls should be equally stable in a culture to develop. Still, because of girl child killings and gender-based abortions, the proportion has been distressed in numerous nations counting in India. In China, the proportion of boys to girls became 140:100 in numerous areas which caused shortage of wives.

Life Expectancy: It is the average age that a newborn infant is expected to attain in a given country. The average life expectancy, over the globe, has risen from 40 to 65.5 years over the past century. In India, life expectancy of males and females was only 22.6 years and 23.3 years, respectively in 1900. In the last 100 years, improved medical facilities and technical progression has amplified the life expectancy to 60.3 years and 60.5 years, respectively for the Indian males and females. In Japan and Sweden, life expectancy is quite higher, being (82.1-84.2) for females and (77-77.4) for males, respectively.

Demographic Transition: Populace development is typically connected to financial growth. There arises a distinctive drop in demise rates and birth rates because of better survival circumstances causing less populace development, a concept termed as demographic transition:

It is related with urban development and arises in four stages:

(a) **Pre-Industrial Phase** considered by huge development and demise rates and net populace development is less.

(b) **Transitional Phase** arises with the arrival of industrial development offering improved sanitation and medicinal amenities and satisfactory diet, thus dropping demises. Birth rates, still, stay huge and the populace displays 2.5-3% progress rate.

(c) **Industrial Phase** while there is a drop in birth rates, thus dropping development proportion.

(d) **Post-Industrial Phase** during which nil populace development is attained.

Demographic evolution is seen in maximum emerging countries. As an outcome of demographic evolution, the advanced countries are nowadays rising at a proportion of approximately 0.5% with a doubling up time of 118 years. Still, the matter of fear is that further than 90% of the worldwide populace is focused in emerging countries which have a development proportion a slightly more than 2%, and a doubling up time of less than 35 years.

6.4 Population Explosion

There has been a severe decrease in the doubling up period of the worldwide human inhabitants. Human populace has developed rapidly than before. Between 1950-1990, in four decades, the populace surpassed 5 billion mark with present totaling of approximately 92 million annually. In the year 2000, the world populace was 6.3 billion and it is projected to develop 4 times in the approaching 10 decades. This unparalleled progress of human populace at a disturbing proportion is termed as **population explosion.**

The Indian Scenario

India is the 2nd populated nation of the world with 1 billion individuals. If the present development proportion stays, it will have 1.63 billion people by 2050 and will become the maximum populated nation outstanding China. So, we are marching towards severe consequences of the populace explosion issue. Looking at the populace figures of India, **in 35 years, after freedom, we added another India in terms of population.** On 11th May, 2000, we became 1 billion and now we can say that every 6th person in this world is an Indian.

The Population Clock

Every second, on an average, 4-5 children are born and 2 people die, thus resulting in net gain of nearly 2.5 people every second. This means that every hour we are growing by about 9,000 and every day by about 2,14,000.

Populace explosion is triggering serious reductions of natural reserve and ecological deprivation. Our resources like land, water, remnant fuels, ore reserves etc. are inadequate, and because of extreme consumption, they are getting depleted. Numerous non-conventional sources like woodlands, plains, etc. are under great burden. Manufacturing and financial development are levitating our lifestyle standards but adding poisonous contaminants into the air, water and soil. As an outcome, the environmental life support structures are getting endangered. There is a severe argument on this subject as to whether we must instantly lessen fertility rates by global birth control programmes to steady or human beings will devise new technologies for substitute sources, so that the problem of surpassing the capacity of the earth will never arise.

Two significant opinions on populace development are referred here:

Malthusian Theory: According to Malthus, human populaces incline to rise at an exponential or compound rate while diet manufacture upsurges gradually or stays even. Thus, hunger, deficiency, illness, corruption and desolation are always related with populace explosion. He believes “positive checks” such as scarcities, illness epidemic and ferocity as well as “preventive checks” like birth control require to steady populace development.

Marxian Theory: According to Karl Marx, populace development is an indication rather than the reason of deficiency, reserve exhaustion, contamination and other

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societal troubles. He believed that societal misuse and domination of the underprivileged individuals results in deficiency, joblessness and ecological deprivation that in turn, reasons in overpopulation.

A negotiation amongst the twp opinions is essential since these issues appear to be codependent. Societal righteousness and letting everybody to relish a decent lifestyle is present requirement to benefit in attaining a steadied worldwide populace.

Family Welfare Models

Population explosion is like a time bomb that must be diffused well in time. The population must be kept much below the carrying capacity and stabilized, so that the aftermath of explosion could be avoided.

It is not precisely known as to how long can we continue our exponential growth in population and resource use without suffering overshoot or dieback. We are getting warning signals that if not controlled, the increasing population is going to deplete all the resources beyond their regeneration capacity. A catastrophic doomsday model warns us that the earth cannot sustain more than two more doublings, i.e., 25 billion. The United Nations projections about population stabilization of developed and developing nations and that of Asia are shown. The ratio is derived by dividing crude birth rate by crude death rate. As evident, developed nations have already achieved a stabilization ratio of 1 around the year 2000, which is more or less stabilized indicating zero population growth. Developing nations including Asia, on the flip side, is yet having a high stabilization ratio nearing 3, which is however, on a decline and is expected to lower down substantially by 2025. Stabilization in developing nations is possible only through various family welfare programmes.

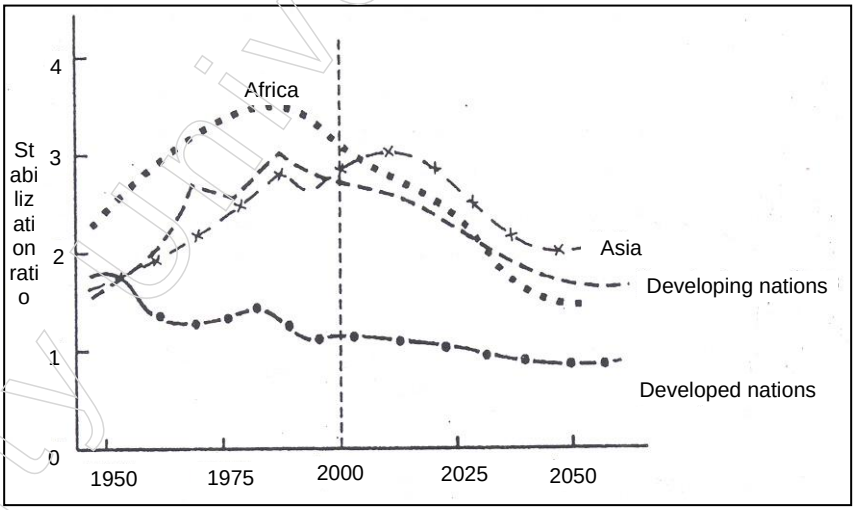

Fig. 6.3: Stabilization Ratio of Developing and Developed Nations, Africa and Asia. A ratio of 1 achieved in developed nations around 2000 indicates zero population growth in developed nations while Africa is presently having the highest ratio.

The Kerala Model – A Case Study

Kerala has achieved the recognition of having lowermost birth rates amongst other states of India. The foremost constraints determining the effectiveness of this model hinge on the age of marriage for women at 21 years, as against an Indian average of 18 years, female literacy of 53% against Indian average of 13%, better stress on prime schooling with 60% budget provision for the same against 50% in many other states improved civic circulation structure of diet among 97% of population, improved medicinal

services in rural areas and better achievement of family planning programmes. The Kerala Model has its own achievement story highlighting the successful societal fairness method for family planning.

6.5 Family Welfare Programmes

Family welfare programmes allows couples to decide their family size and also the time spacing of their off-spring. Almost, every culture in the past used to practice some traditional fertility control methods through some traditions, taboos and folk medicine.

Modern science has provided several birth control techniques including mechanical barriers, surgical method, chemical pills and physical barriers to implantation. More than a hundred contraceptive methods are on trial. The **United Nations Family Planning Agency** provides funds to 135 countries. Many of these countries include abortion as a method of the population control programme which very often encourages female infanticide thereby disturbing the optimal male-female ratio in a culture. The birth control programmes have often faced strong opposition from religious groups.

Nonetheless, **World Health Organization (WHO)** estimates that today about 50% of the worlds' married couples adopt some family planning measures as compared to just 10% about 30 years back. Still some 300 million pairs lack knowledge of family planning.

The Indian Context

India started the family planning programme in 1952 while its population was nearly 400 million. In 1970s, forced family planning campaign by the Government resulted in a turmoil all over the country. In 1978, the government raised the legal least age of wedding from 18 to 21 years for men and 15 to 18 years for women. Even in 1981 census, no drop in population growth was observed. Since then, funding for family planning programmes has been increased further.

Unable to reach a consensus regarding population policy, the state governments in 2000 were allowed to adopt their own approach. In Kerala, the population has been stabilized with a focus on social justice as already discussed. It is now comparable to many industrialized nations including USA and it has proved that wealth is not a pre-requisite for zero population growth (ZPG). Andhra Pradesh has also just achieved the target of ZPG in 2001, but it has been done with a different approach. The poor class was encouraged to be sterilized after two children by paying cash incentives, better land, housing, wells and subsidized loans. In contrast, Bihar and UP have showed increase in their growth rates (more than 2.5%).

Successful family planning programmes need significant societal changes including social, educational and economic status for women, social security, political stability, proper awareness and confidence building along with accessibility and affectivity of the birth control measures.

The Urban Challenge

Population increase will continue in urban centers in the near future. The UN has shown that by 2025 there will be 21 'megacities', most of which will be situated in developing countries. Urban centers are already unable to provide for adequate housing, services such as water and drainage systems, growing energy needs, or better opportunities for income generation.

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Methods of Sterilization

India's FWP has been fairly successful, but much still needs to be achieved to stabilize our population The FWP advocates a variety of measures to control population. Permanent methods or sterilization are completed by a slight operation. Tubectomy in females is done by tying the tubes that carry the ovum to the uterus. Male sterilization or vasectomy is done by tying the tubes that carry the sperm.

Urbanization

In 1975, only 27% of the individuals in the emerging phase existed in city parts. By 2000, this had raised to 40% and by 2030, well knowledgeable estimations say that this will raise to 56%. The developed world is already highly urbanized with 75% of its populace existing in city parts.

Urban population growth is both due to migration of people to towns and cities from the rural areas to obtain good employment chances as well as population growth within cities.

As a rural town improves into a metropolitan, it not only spreads outwards into the surrounding agricultural lands or natural areas such as forests, grasslands and wetlands, but also grows skywards with high-rise buildings. The town often loses its barren parts and forestry lands unless consciously preserved leading to the devastation of the standard lifestyle in city zones.

Good urban planning is essential for rational land use, upgrading slum areas, improving water supply and drainage systems, providing adequate sanitation, and developing effective waste water treatment plants and an efficient public transport system.

While all these issues appear to be under the purview of local Municipal Corporations, better living conditions can become a reality only if every citizen plays an active role in managing the environment. This includes a variety of "Do's and Don'ts" that should become an integral part of our personal lives.

Unplanned and haphazard growth of urban complexes causes serious environmental impacts. Increasing solid waste, improper garbage disposal, air and water pollution are frequent side-effects of urban expansions.

Case Study – 1:

Urban Environments

Nearly half the world's population now lives in urban areas. The extreme populace density in these parts causes severe ecological problems. Currently, more than 290 million individuals live in townships and metropolises in India. There were 23 metros in India in 1991, which grew to 40 by 2001.

Apart from undertaking actions that support the environment, every urban individual has the ability to influence a city's management. He or she must see that the city's natural green spaces, parks and gardens are maintained, river and water fronts are managed appropriately, roadside tree cover is maintained, hill slopes are afforested and used as open spaces, and architectural and heritage sites are protected. Failure to do this leads to increasing urban problems which eventually destroy a city's capability to preserve a healthy and happy lifestyle for its dwellers. Altogether these characteristics are carefully connected to the populace development in the city area. In many cities. population growth often outstrips the planner's ability to respond in time.

(c) Amity University Online

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Table 6.1

Megacities in India	Population (in millions) in 2001	Projection (in millions) for 2015
Mumbai	16.5	22.6
Kolkata	13.3	16.7
Delhi	13.0	20.9

6.6 Environment and Human Health

Ecology linked problems that impact our well-being have been a prime trigger in the growing alertness of the necessity for improved ecological administration. The changes in our environments encouraged by human actions deviations in our atmosphere encouraged by humanoid actions in closely influencing our healthiness. The supposition that the solitary indicator of human development is financial progress is false. We assume urbanization and industrial development to bring in wealth, in but on the shortcoming, it causes ailments linked to overpopulation and contaminated drinking water, ensuing in a rise in waterborne illnesses like infectious diarrhea and airborne microbial illnesses like tuberculosis. High density urban road traffic causes an upsurge in breathing ailments like asthma. Farming insecticides that improved provisions at the time of green revolution have impacted the farmers and the entire population who consumes it. Minor city centers will raise speedily in the coming decade and numerous countryside parts will need re-classification as city centers. India's city parts will raise by an anticipated 297 million inhabitants. In India, people shift to metropolises from countryside parts in the expectation of making improved revenues. This is the 'Pull' factor. Deprived chances in the countryside area therefore arouse relocation to metropolises. The harm of farming property to urbanization and manufacturing units, the incapability of administrations to sustain and grow the township area and an absence of backup substructure in townships, altogether encourage individuals from the farming and organic woodland ecologies into the city area.

As our growth policies have fixated consideration typically on fast manufacturing expansion and comparatively less growth choices are presented for the farming township areas, a move of populace is unavoidable.

Statistics

As populations in urban centers grow, they draw on resources from more and more distant areas. "The Ecological Footprint" corresponds to the land area necessary to supply natural resources to a community and disposal of its waste. At present, the average ecological footprint of an individual at an international stage is said to be 2.3 ha of land per capita. It is estimated though, that the world has only 1.7 ha of land per individual to manage these needs thus leading to an unsustainable use of land.

The pull factor of the urban centers is not only due to better job opportunities, but also better education, health care and relatively higher living standards. In the past few years, India has seen improvements in the supply of clean water, sanitation, waste management, education and health care have all been urban-centric, even though the stated policy has been to support rural development. In reality, growth has delayed behind it the rural sector that is rapidly expanding in numbers. For people living in wilderness areas in our forests and mountain regions, development has been most neglected. It is not appropriate to use the development methods used for other rural communities for tribal people who are dependent on collecting natural resources from

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the forests. A different pattern of development which is based on the sustainable extraction of resources from their own surroundings would satisfy their aspirations. In general, though the growing human populations in the rural sector will opt to live where they are only if they are given an equally satisfying lifestyle as they would get in an urban sector.

The Wilderness-Rural-Urban Link

The environmental stresses caused by urban individuals covers an 'ecological footprint' that goes far beyond what one imagines. The urban sector not solitarily disturbs the land at the fringes of the urban area. but also the areas from which the urban center pulls in agricultural and natural resources.

Urban centers occupy 2% of the world's land, but use 75% of wood available. About 60% of the world's water is used by urban areas of which half irrigates food crops for urban dwellers, one-third goes towards industrial use, and the rest for household use and drinking water.

The impact that urban dwellers have on the environment is not obvious to them as it affects distant places which support the urban ecosystem using resources from agricultural and even more remote wilderness ecosystems.

Economic inequality and environmental changes are closely connected to each other, poor countries are unable to meet required emission standards to slow down climate change. The depletion of ozone in the stratosphere (middle atmosphere) also has an important impact on global climate and, in turn, human health, increasing the amount of harmful UV radiation that reaches the Earth's surface. This results in diseases such as skin cancer.

Development strategies that do not include environmental protections frequently results in bad well-being, whereas policies that can encourage healthiness consistently also defend the atmosphere. Therefore, ecological well-being and humanoid healthiness are carefully associated. A development in well-being is dominant to complete ecological administration. Though, this is seldom given adequate significance in developing expansion policies.

Examples of the Links

- Millions of children die every year due to diarrhea from contaminated water or food. An estimated 2000 million people are affected by these diseases and more than 3 million children die each year from waterborne diseases across the world. In India, it is projected that every fifth child under the age of 5 dies due to diarrhea. This is a result of insufficient ecological administration and is mainly due to insufficient distillation of drinking water. Wastewater and/or sewage entering water sources without being treated causes constant intestinal illnesses in the community and even sporadic large epidemics. Large number of people in tropical countries die of malaria every year and millions are infected. An inadequate environmental management of stagnant water, the breeding site of the *Anopheles* mosquito, is the most important factor in the spread of malaria. The resurgence of malaria in India is leading to cerebral malaria that affects the brain and has a high mortality.
- Millions of people, mainly children have poor health due to parasitic infections, such as amoebiasis and worms occurs from eating infected food, or using poor quality water for cooking food. It is estimated that 36% of children in low-income countries and 12% in middle-income countries are malnourished. In

(c) Amity University Online

India, about half the children under the age of four are malnourished and 30% of newborns are significantly underweight.

- Hundreds of millions of people suffer serious respiratory diseases, including lung cancer and tuberculosis, from ill-ventilated homes and public places. Motor vehicle exhaust fumes, industrial fumes. Tobacco smoke and cooking food on improper *chulas* contribute to respiratory diseases.
- Millions of people are exposed to hazardous chemicals in their workplace or homes that lead to poor health due to industrial products where controls are not adhered to.
- Thousands of people in the world die due to traffic accidents owing to inadequate management of traffic conditions. Ineffective first aid at the accident site and the frequent inability to reach hospital within an hour causes a large number of deaths, especially from head injuries.
- Basic environmental needs – such as clean water, clean air and adequate nutrition – which are all related to environmental goods and services do not reach over 1000 million people living in abject poverty.
- Several million people live in inadequate shelters or have no roof over their heads especially in urban settings. This is related to high inequalities in the distribution of wealth and living.
- Population growth and the way resources are being exploited and wasted threaten environmental integrity and directly affects the health of every individual.
- Health is an outcome of the interactions between people and their environment. Better health can only come from more sustainable environmental management.

Important Strategic Concerns

- The world must address people's health care needs and the sustainable use of natural resources, which are carefully associated to one another.
- Strategies to provide clean potable water and nutrition to all people are an important part of a healthy living environment.
- Providing clean energy sources that do not affect health is a key to reducing respiratory diseases.
- Reducing the environmental consequences of industrial and other pollutants, such as transport emissions, can improve public health.
- Changing agricultural patterns away from harmful pesticides, herbicides and insecticides which are injurious to the health of farmers and consumers and using alternatives, such as IPM and non-toxic biopesticides, can improve the health of agricultural communities as well as food consumers.
- Changing industrial systems into those that do not use or release toxic chemicals that impact the well-being of workers and people living in the vicinity of industries can improve health and environment.
- There is a necessity to change from using conventional energy to cleaner and safer sources like solar, wind and ocean power that do not affect human health. Providing clean energy will lead to better health.
- The key factors are to control human population and consume less environmental goods and services which could lead to 'health for all'.

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- Poverty is closely related to health and is itself a consequence of improper environmental management. An inequitable sharing of natural resources and environmental goods and services is linked to poor health.

Definition of Health Impact Assessment (HIA): The WHO defines HIA as a combination of procedures, methods and tools by which a policy, programme or project may be judged as to its potential effects on the health of a population and the distribution of those effects within the population. Modern medicine promised to solve many health problems, especially associated with infectious diseases through antibiotics, but bacteria have found ways to develop resistant strains, frequently even changing their behavior in the process, making it necessary to keep on creating newer antibiotics. Many drugs have been found to have serious side-effects. Sometimes, the cure is as damaging as the disease process itself.

Thus, development has created several long-term health problems. While better health care has led to longer lifespans, coupled with lowered infant mortality, it has also led to an unprecedented growth in our population which has negative implications on environmental quality. A better health status of society will bring about a better way of life only if it is coupled with stabilizing population growth.

Health and Climate

Environmental health, as defined by WHO, contains those features of humanoid well-being, counting in the standard of lifestyle, that are determined by physical, chemical, biological and social features in the atmosphere. It also mentions the philosophy and training of evaluating, modifying monitoring, and averting those features in the atmosphere that unfavorably impact the well-being of current and upcoming generations.

Our atmosphere impacts well-being in a various kind. Temperature and weather conditions impact human healthiness. Civic well-being hinges on adequate quantities of good quality food, safe drinking water, and satisfactory accommodation. Natural tragedies such as hurricanes and inundations still kill many people every year. Extraordinary precipitation causes epidemics of malaria and water-borne ailments.

Worldwide weather alteration has severe well-being consequences. Numerous nations will have to adjust to indefinite climatic circumstances because of global warming. As our weather is altering, we may no longer know what to expect. There are increasing storms in some countries, drought in others, and a temperature rise throughout the world. The El Nino winds affect weather worldwide. The EI Nino event of 1997-98 had serious impacts on health and well-being of millions of people in many countries. It created serious drought, floods, and triggered epidemics. New strategies must be evolved to reduce our vulnerability to climate variability and changes.

Case Study – 2:

The Bhopal Gas Tragedy

The uncaring placement of manufacturing and comparatively bad controlling causes poor well-being in the city centers. The Bhopal Gas Tragedy on December 2, 1984, where Union Carbide's plant leaked 43 tons of methyl isocyanate and other substances used in the manufacture of pesticides, is one of the worst industrial accidents in the recent past. Of the 520,000 people who were exposed to the gas, 8,000 died during the first week and another 8,000 later. The impact on the survivors is visible even today.

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Centuries of human civilization have helped mankind to adapt to living in a wide variety of climates – from the hot tropics to the cold arctic, in deserts, marshlands and in the high mountains. Both climate and weather have a powerful impact on human life and health issues.

Natural disasters (heavy rains, floods and hurricanes) can severely affect the health of a community. Poor people are more vulnerable to the health impacts of climate variability than the rich. Of approximately 80,000 deaths which occur worldwide each year as a result of natural disasters, about 95% are in poor countries. In weather-triggered disasters, hundreds of people and animals die, homes are destroyed, and crops and other resources are lost. Public health infrastructure, like sewage disposal systems, waste management, hospitals and roads, are damaged. The cyclone in Orissa in 1999 caused 10,000 deaths. The total number of people affected was estimated at 10 to 15 million.

Human physiology can adapt to changes in weather, within certain limits. However, marked short-term variations in climate caused severe well-being problems. Heat waves cause heat-related illness and death (e.g., heat stroke). The elderly and individuals with prevailing heart or breathing illnesses are more susceptible. The heat wave in India in 1998 was associated with many deaths.

Climate plays an important role in vector-borne diseases transmitted by insects like mosquitoes. These disease transmitters are sensitive to the direct effects of climate, such as temperature, rainfall patterns and wind. Weather impacts their circulation and profusion by its outcomes on mass number of floras and faunas.

Malaria transmission is particularly sensitive to weather and climate. Unusual weather conditions, for example, a heavy downpour, can greatly increase the mosquito population and trigger an epidemic. In the desert and at the highland fringes of malarial areas, malaria transmission is unstable and the human population lacks inherent protective immunity. Thus, when weather conditions (rainfall and temperature) favor transmission, serious epidemics occur in such areas. The fluctuations in malaria over the years have also been linked to changes in rainfall associated with the El Nino cycle.

Infectious Diseases

Numerous transferrable illnesses have re-emerged with a retaliation. The damage of operative regulation over ailments, like malaria and tuberculosis, have caused a reoccurrence of these illnesses years after being kept below strict regulation.

Other diseases, which were not known to science earlier, seem to have suddenly hit our health and our lives during the last few decades. Two examples are Acute Immuno- Depressive Syndrome (AIDS), due to the Human Immunodeficiency Virus (HIV) caused through sexual transmission and Severe Acute Respiratory Syndrome (SARS). While these cannot be directly related to environmental change, they affect the environment in which we live by forcing a change in lifestyles and behavior patterns. For example, the SARS outbreak prevented people from several countries from traveling to other countries for months, severely affecting national economies, airline companies and the tourism industry.

Diseases like tuberculosis have been effectively treated with anti-tubercular drugs for decades. These antibiotics are used to kill off the bacteria that cause the disease. However, nature's evolutionary procedures allowed the microorganisms to alter by forming newfangled genetically-modified straining. These mutated strains, which are not affected by the routinely-used antibiotics, started to spread out quickly. This leads to a re-emergence of the disease. In the case of tuberculosis, this has led to multi-drug

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resistant tuberculosis. This is frequently related to HIV, which reduces an individual's immunity to bacteria, such as *mycobacterium tuberculosis* that causes tuberculosis.

The newer broad-spectrum antibiotics, antiseptics, disinfectants, and vaccines once thought of as the complete answer to infectious diseases have thus failed to eradicate infectious diseases. In fact, experts now feel that these diseases will be the greatest killers in the future and not diseases such as cancer or heart disease.

While antibiotic resistance is a well-known phenomenon, there are other reasons for the re-emergence of diseases. Overcrowding due to the creation of slum area in the city location causes numerous well-being dangers, including easier spread of respiratory diseases. Inadequate drinking water quality, poor disposal of human waste due to the absence of a closed sewage system, and poor garbage management are all urban health issues. This has led to the reappearance of diseases such as cholera and an amplified occurrence of diarrhea and dysentery as well as infectious hepatitis (jaundice).

With increasing global warming, disease patterns will continue to change. Tropical diseases spread by vectors like mosquitoes will undoubtedly spread malaria further away from the Equator. Global warming will also change the distribution of dengue, yellow fever, encephalitis, etc. Warmer wetter climates could cause serious epidemics of diseases such as cholera. The El Nino, which causes periodic warming, is likely to affect rodent populations; this could bring back diseases like the plague.

Globalization and Infectious Disease

Globalization is a universal procedure which consists of the internationalization of communication, employment and financial association. It involves parallel changes such as rapid social, economic and political adjustments. Whilst globalization has the potential to enhance the lives and living standards of certain population groups, for the poor and marginalized populations in both the non-formal as well as formal economic sectors of developing countries, globalization enhances economic inequalities.

Tuberculosis (TB) kills almost 2 million individuals annually. In India, the disease has re-emerged and is now more difficult to treat. In 1993, the WHO declared that TB had become a worldwide emergency. It is estimated that between 2002 and 2020, approximately 1000 million people will be newly infected, over 150 million people will get sick and 36 million will die of TB if its regulation is not quickly reinforced.

TB is a contagious disease that is spread through the air. Only people who are sick with pulmonary TB are infectious. When infectious people cough, sneeze, talk or spit, they emit the tubercle bacilli into the air. When a healthy person inhales these, he/she gets infected by the disease. The symptoms include prolonged fever, coughing spells and weight loss.

It is projected that, if not treated in time, every patient of active tuberculosis will infect, on an average, between 10-15 people every year. But people infected with TB will not necessarily get sick with the disease. The immune system can cause the TB bacilli, which is protected by a thick waxy coat, to remain dormant for years. When an individual's immune system is weakened, the chances of getting active TB are greater.

Some Facts about TB

- Nearly 1% of the world's population is newly infected with TB each year.
- It is estimated that overall, one-third of the world's population is likely to be infected with the tuberculosis bacillus at some point in time.
- 5-10% of the people who are infected with TB (but who are not infected with HIV) become sick or infectious at some time during their life (WHO, 2002).

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- TB kills about 2 million people each year (including persons infected with HIV).
- More than 8 million people become sick with TB each year, one person in the world every second.
- About 2 million TB cases per year occur in sub-Saharan Africa. This number is rising rapidly as a result of the HIV AIDS epidemic.

- Around 3 million TB cases per year occur in South-east Asia.
- Over a quarter of a million TB cases per year occur in Eastern Europe.

Case Study – 3:

Tuberculosis in India

There are 14 million TB patients in India, accounting for one-third of the global cases of TB. Every day, 20,000 Indians contract TB and more than 1,000 die due to this chronic illness. TB attacks working adults in the age group of 15-50 years.

HIV is Accelerating the Spread of TB

The link between HIV and TB affects a huge sum of individuals, each disease speeding the other's progress. HIV weakens the immune system. Someone who is HIV positive and infected with TB is much further probable to become seriously ill with TB, rather than someone infected with TB who is HIV-negative. TB is a foremost reason of demise amongst individuals who are HIV-positive, accounting for about 11% of AIDS deaths worldwide.

Poorly-managed TB Programmes are Threatening to Make TB Incurable

Until 50 years ago, there were no drugs to cure tuberculosis. Today, stresses that are resilient to one or more anti-TB drugs have appeared. Drug-resistant tuberculosis is caused by unreliable or incomplete treatment, when patients do not take all their drugs regularly for the mandatory time, when doctors or health workers recommend insufficient treatment routines, or where the drug source is undependable. From a public-health viewpoint, badly managed or partial treatment of TB is worse than no treatment at all. When people fail to complete standard treatment regimes, or are given the incorrect treatment, they might stay transmittable. The bacilli in their lungs may develop resistance to anti-TB drugs. The people that they infect will have the same drug-resistant strain. While drug-resistant TB is treatable, it needs excessive chemotherapy that is normally costly and is also additionally poisonous to patients.

Malaria

Malaria is a life-threatening parasitic disease transmitted by mosquitoes. The cause of malaria, a single-celled parasite called plasmodium, was discovered in 1880. Later, it was found that the parasite is spread from each individual through the bite of a female *Anopheles* mosquito, which needs blood for the development of her eggs.

At present, approximately 40% of the world's inhabitants, typically those living in the world's underprivileged nations, are at a danger of receiving malaria. The disease was once more widespread, but it was successfully eliminated from many countries with temperate climates during the mid-20th century. Today, malaria has come back and is seen all over the tropical and sub-tropical regions of the world and causes more than 300 million acute illnesses and at least one million deaths annually (WHO).

There are several types of human malaria. *Falciparum* malaria is the most dangerous type of infection and is most common in Africa south of the Sahara, where it

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accounts for extremely high mortality rates. There are also indications of the spread of *P. falciparum* malaria in India and it has reappeared in areas where it had been eliminated.

The malaria parasite enters the human host when an infected *Anopheles* mosquito bites an individual. Inside the human host, the parasite experiences a sequence of variations as part of its multifaceted lifespan. Its numerous phases permit the plasmodia to evade the immune system, infect the liver and red blood cells, and lastly grow into a system that is able to infect a mosquito again when it bites an infected person. Inside the mosquito, the parasite matures until it reaches the sexual stage where it can again infect a human host when the mosquito takes her next blood meal, 10 or more days later.

Malarial symptoms appear about 9-14 days after the mosquito bite, although this varies with different plasmodium species. Malaria produces high fever, headache, vomiting and body ache. If drugs are not available for treatment, or the parasites are resistant to them, the infection can progress rapidly to become life-threatening. Malaria can kill by infecting and destroying red blood cells (anemia) and by blocking the veins that carry blood to the brain (cerebral malaria) or other vital organs.

Malaria parasites are evolving undesirable stages of resilience to drugs. Besides this, many pesticides fail to be beneficial in contradiction of the mosquitoes spreading the illness. Prevention of malaria in pregnant women, through measures such as the Intermittent Preventive Treatment (IPTN) and the use of Insecticide-treated nets (ITNs), results in development in motherly well-being, as well as infant health and survival. Quick admission to treatment with active latest drugs, like Artemisinin-based Combination Therapies (ACTs), protects lives. If nations can implement these and other procedures on an extensive scale and screen them cautiously, the load of malaria on society will be noticeably lessened.

Water-related Diseases

Water supply, Sanitation and Hygiene Development

Among the main problems are a lack of priority given to this sector, lack of financial resources, unpredictable water stock and hygiene facilities, poor hygiene-related behaviour patterns, and insufficient cleanliness in community areas like schools, hotels, hospitals, health centers, etc. One of the most significant features is an absence of ecological schooling and alertness that these illness courses are linked to bad atmosphere administration in numerous areas.

Providing access to adequate amounts of safe water, facilities for the sanitary disposal of excreta, and introducing sound hygiene-related behavior can decrease illness and death instigated by these dangerous issues.

Environmental Sanitation and Hygiene Development

Globally, about 2.4 billion people live under highly unsanitary conditions. Bad sanitation upsurges the contact to hazard of occurrence and spread of transferrable illnesses. Water improperly stored in homes is often polluted by insufficient supervision at the household level. This can be simply decreased through instruction and alertness about how water-borne illnesses are spread.

Health and Water Resources Development

A significant feature of water-related diseases (in particular, water-related vector-borne diseases) is the way water resources are advanced and controlled. In many parts of the world, the opposing well-being effects of dam construction, irrigation development

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and flood control are linked to amplified occurrence of malaria, Japanese encephalitis, schistosomiasis, lymphatic filariasis, and other conditions. Other health issues indirectly related with water resources development include nutritional status, contact to farming insecticides and their remains.

Water-borne Diseases

Arid areas with rapidly expanding populations are already facing a crisis over water. Conservation of water and better management is an urgent need. The demand and supply balance are a vital part of developing the sustainable use of water. This is being termed the 'Blue Revolution' and needs Governments, NGOs and people to work together towards a better water policy at the international, national, state, regional and local levels. The present patterns of development are water-hungry and water-wasters. They do not address pollution and overuse. The links between managing water resources and health issues have not been prioritized as a major source of environmental problems that require policy change, administrative capacity building and increased financial support.

There are four major types of water-related diseases:

1. **Water-borne Diseases:** These are instigated by muddy water polluted by man-made and animal waste matters, particularly from city dirt, or by biochemical waste matters from manufacturing and farming. Few of these illnesses, such as cholera and typhoid, reason in severe epidemics. Diarrhea, dysentery, polio, meningitis, and hepatitis A and E are triggered due to inappropriate drinking water. Excessive levels of nitrates cause blood illnesses when they contaminate water sources. Insecticides contacting the drinking water in rural areas cause cancer, neurological diseases and infertility. Refining cleanliness and offering treated drinking water decreases the occurrence of these illnesses.
2. **Water-based Diseases:** Aquatic organisms that live a portion of their lifespan in water and another part as a parasite in man, lead to numerous illnesses. In India, guinea worm affects the feet. Roundworms live in the small intestine, especially of children.
3. **Water-related Vector Diseases:** Insects like mosquitoes that breed in stagnant water spread diseases such as malaria and filariasis. Malaria, once effectively controlled in India, has returned as the mosquitoes have become resistant to insecticides. In addition, anti-malarial drugs are now unable to kill the parasites as they have become resistant to drugs. Changes in climate are leading to the formation of new breeding sites. Other vector-borne diseases in India include dengue fever and filariasis. Dengue fever carries high mortality, and filariasis leads to fever and chronic swelling of the legs.

   Eliminating mosquito-breeding sites when pooling of water occurs in the monsoon and using fish to control mosquito larval populations are the two ways to reduce these diseases without using toxic insecticides that have ill-effects on human health.
4. **Water-scarcity Diseases:** In parts where water and hygiene are deprived, there is a high occurrence of illnesses, such as tuberculosis, leprosy, tetanus, etc. which occur when one's hands are not correctly washed. The absence of water causes deprived sanitation.

Arsenic in Drinking Water: Arsenic in drinking water is a severe danger to human well-being. It has disturbed much consideration since the recognition in the 1990s of its wide occurrences in well water in Bangladesh. It arises not that often in maximum other

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nations. The core foundation of arsenic in drinking water is arsenic-rich rocks through which the water has filtered. It might also arise because of evacuation or manufacturing action in few parts. WHO has worked with other UN organizations to produce a state-of-the-art review on arsenic in drinking water.

Case Study – 4:

Arsenic Poisoning – Bangladesh

More than half the population of Bangladesh is threatened by high levels of arsenic found in drinking water. This could ultimately cause an epidemic of cancers and additional lethal sicknesses.

Rezaul Morol, a young Bangladeshi man, nearly died from arsenic poisoning caused by drinking arsenic-laden well water for several years. The doctor advised Rezaul to stop drinking polluted water and eat more protein-rich food, such as fish. Since then, Rezaul feels a lot better and is happy that his skin is healing.

Drinking water that is rich in arsenic leads to arsenic poisoning or 'arsenicosis'. The well-being impacts are usually late and the maximum operative precautionary step is providing drinking water which is free of arsenic. Arsenic pollution of water is also due to manufacturing procedures such as those involved in mining, metal refining and timber treatment. Undernourishment may intensify the impacts of arsenic on blood vessels.

Water with high concentrations of Arsenic if consumed for a long time, can result in health consequences. There are colour changes of skin, patches in palms and soles, cancers, lungs and Kidney problems etc. It may also lead to diabetes, high blood pressure and reproductive disorders.

Natural arsenic contamination occurs in Argentina, Bangladesh, Chile, China, India, Mexico, Thailand and the United States. In China (in the Province of Taiwan), exposure to arsenic leads to gangrene, known as 'black foot disease'.

Long-term solutions for prevention of arsenicosis are based on providing safe drinking water. Some measures are:

- Digging deeper wells, as these are less probable to be polluted.
- Testing of water for levels of arsenic and informing users.
- Monitoring by health workers – people need to be checked for early signs of arsenicosis, usually by observing skin problems in areas where arsenic is known to occur.

Diarrhea

Though several types of diarrhea, which give rise to loose motions and dehydration, occur all over the world, this is especially often detected in emerging nations. It causes 4% of all deaths. In another 5%, it leads to loss of health. It is instigated by intestinal poisons, which kill around 2.2 million individuals at an international level annually. Maximum of these are kids in the emerging nations. The usage of polluted water is a significant reason of this cluster of circumstances. Cholera and dysentery cause severe, sometimes life-threatening and epidemic forms of these diseases.

Effects on Health: Diarrhea is the regular passage of loose or liquid stools, and is an indication of numerous intestinal poisons. Depending on the type of infection, the diarrhea may be watery (e.g., in cholera caused by *vibrio* cholera) or passed with blood and mucus (in dysentery caused by an amoeba, *E. histolitica*).

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Depending on the type of infection, it may last a few days or several weeks. Severe diarrhea can become life-threatening due to the acute loss of fluids and electrolytes, such as sodium and potassium in watery diarrhea. This is predominantly deadly in newborns and young kids. It is also hazardous in undernourished people and individuals with deprived resistance.

The influence of recurrent diarrhea on nutritional status is related in a malicious sequence in kids; biochemical or non-infectious abdominal situations can also outcome in diarrhea.

Causes of Diarrhea: Diarrhea is triggered by numerous microbial, virus-related and parasitic creatures. They are mostly spread by polluted water. It is more common when there is a scarcity of hygienic water for drinking, cooking and cleaning. Basic sanitation is a significant feature in its stoppage.

Water contaminated with human feces surrounding a rural water source, or from municipal sewage, septic tanks and latrines in city centers are significant issues in the transmission of these illnesses. The feces of livestock also comprise bacteria that can reason in diarrhea through water.

Diarrhea is transmitted from person to person because of bad sanitation. Food is a major cause of diarrhea when it is prepared or stored in unsanitary settings. Water can contaminate food such as vegetables during irrigation. Fish and seafood from polluted water can also be the cause of severe diarrhea.

The infectious agents that cause diarrhea are present in our environment. In developed countries where good sanitation is available, most people get enough safe drinking water. Good personal and domestic hygiene prevents this disease which is predominantly seen in the developing world. About 1 billion people do not have access to clean water sources and 2.4 billion have no basic sanitation (WHO website). In South-east Asia, diarrhea is responsible for 8.5% of all deaths. In 1998, diarrhea was estimated to have killed 2.2 million people, most of whom were under 5 years of age (WHO, 2000).

Interventions: Key measures to reduce the number of cases of diarrhea include:

- Access to safe drinking water.
- Improved sanitation.
- Good personal arid food hygiene.
- Health education about how these infections spread.

Key measures to treat diarrhea include:

- Giving more fluids than usual (oral rehydration) with salt and sugar to prevent dehydration.
- Continued feeding.
- Consulting a health worker if there are signs of dehydration or other problems.

In rural India, during the last decade, public education through posters and other types of communication strategies has lessened newborn death due to diarrhea in several states. Posters depicting a child with diarrhea being given a water, salt and sugar solution to reduce death from dehydration has gone a long way in reducing both a serious condition requiring hospitalization and intravenous fluids as well as mortality.

Risks Due to Chemicals in Food

Food contaminated by chemicals is a significant civic well-being alarm. This pollution may arise through ecological contamination of the air, water and soil. Toxic metals, PCBs and dioxins, or the intentional usage of numerous elements, like

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insecticides, animal drugs and other agrochemicals have serious consequences on human health. Food additives and contaminants used during food manufacture and processing also unfavorably disturb humanoid well-being.

Diseases Spread by Food: Some food-borne diseases, though well recognized, have recently become more common. For example, outbreaks of salmonellosis which have been reported for decades, has increased within the last 25 years. In the Western hemisphere and in Europe, Salmonella-serotype Enteritidis (SE) has become a predominant strain. Investigations of SE outbreaks indicate that its emergence is largely related to the consumption of poultry or eggs.

While cholera has devastated much of Asia and Africa for years, its reintroduction for the first time in almost a century on the South American continent in 1991 is an example of a well-recognized infectious disease re-emerging in a region after decades. While cholera is often water-borne, many foods also transmit the infection. In Latin America, ice and raw or under processed seafood are significant reasons for cholera spread.

Infection with a specific type of *Escherichia coli (E. coli)* was first described in 1982. Subsequently, it has emerged rapidly as a major cause of bloody diarrhea and acute renal failure. The infection is sometimes fatal, particularly in children. Outbreaks of infection, usually related with beef, have been reported in Australia, Canada, Japan the US, various European countries, and in southern Africa. Outbreaks have also implicated alfalfa sprouts, unpasteurized fruit juice, lettuce, game meat (meat of wild animals) and cheese curd.

In 1996, an outbreak of *E. coli* in Japan affected over 6,300 school children and resulted in two deaths.

Listeria monocytogenes (Lm): The role of food in the spread of this disorder has been documented lately. In pregnant women, infections with Lm cause abortion and still birth. In infants and persons with a poor immune system, it may lead to septicemia (blood poisoning) and meningitis. The disease is most often related with ingesting of foods like soft cheeses and processed meat products that are kept refrigerated for a long time, because Lm can grow at low temperatures. Outbreaks of listeriosis have been reported from many countries, including Australia, Switzerland, France and the US. Two recent outbreaks of Listeria monocytogenes in France in 2000 and in the USA in 1999 were caused by contaminated pork tongue and hot dogs, respectively.

Food-borne trematodes (worms) are increasing in South-east Asia and Latin America. This is related to a combination of intensive aquaculture production in unsanitary conditions, and the consumption of raw or under processed freshwater fish and fishery products. Food-borne trematodes can cause acute liver disease, and may lead to liver cancer. It is estimated that 40 million people are affected worldwide.

Bovine Spongiform Encephalopathy (BSE) is a fatal, infectious, neurodegenerative illness of livestock. It was originally revealed in the UK in 1985. The reason of the illness was traced to an agent in sheep, which polluted reprocessed bovine carcasses used to make meat and bone-meal additives for cattle feed. Recycling of the BSE agent developed into a common-source epidemic of more than 180,000 diseased animals in the UK alone. The agent affects the brain and spinal cord of cattle which produces sponge-like changes, visible under a microscope. About 19 countries have reported BSE cases and the disease is no longer confined to the European Community. A case of BSE has been reported in a cattle herd in Japan.

In human populations, exposure to the BSE agent (probably in contaminated bovine-based food products) has been strongly linked to the appearance, in 1996, of a new transmissible spongiform encephalopathy of humans called variant Creutzfeldt-

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Jakob Disease (vCJD). By January 2002, 119 people developed vCJD, most from the UK, but 5 cases have also been reported from France.

Cancer and the Environment

Cancer is caused by the hysterical development and transmit of abnormal cells that may disturb nearly any tissue of the body. Lung, colon, rectal and stomach cancer are among the five most usual cancers in the world for both men and women. Among men, lung and stomach cancer are the most usual tumors globally. For women, the utmost usual tumors are breast and cervical cancer. In India, oral and pharyngeal cancers form the maximum usual kind of tumors, which are linked to tobacco chewing.

More than 10 million people are detected with cancer internationally each year. It is projected that there will be 15 million new cases every year by 2020. Cancer causes 6 million demises annually or 12% of the demises globally.

The reasons of numerous tumors are recognized. Therefore, the stoppage of at least one-third of all tumors is probable. Tumor is avoidable by quitting smoking, providing healthy food and avoiding exposure to cancer-causing agents (carcinogens). Early detection and effective treatment is possible for a further one-third of cases. Maximum of the usual tumors are treatable by a mixture of operation, chemotherapy (drugs) or radiotherapy (X-rays). The chance of the cure increases if the tumor is noticed at an initial phase.

HIV/AIDS

AIDS = Acquired Immuno Deficiency Syndrome

Acquired = Which is not present since birth but acquired after birth.

Immunodeficiency = Deficiency of immune functional cells; deficiency to perform the immunological function.

Syndrome = A group of diseases and signs and symptoms of illness.

HIV = Human Immunodeficiency Virus

HIV-positive = The presence of antibodies against HIV in human body is termed as HIV positivity and the person is called HIV-positive (Seropositive). It takes 6-12 weeks after infection for antibodies to rise to detectable levels. There is thus a window period during which the infected person may transmit the infection despite being seropositive.

The latest killer disease that has created nightmares for the medical experts is the Acquired Immuno Deficiency Syndrome (AIDS). Its terrifying spread has earned it the title of the “Pandemic” or an epidemic, which is out of control. This disease has wreaked the social and economic devastation. In the absence of medical defence against AIDS, public education is the only weapon in the fight to limit the spread the infection. Only by influencing personal behavior and lifestyle, we can hope to maintain the ravages of AIDS throughout.

Virus

HIV belongs to the family Retroviridae and subfamily Lentivirinae. Two different types of HIV have been recognized and are called as HIV-1 and HIV-2. Both differ in geographical distribution, biological and molecular characteristics and extent of transmissibility. These viruses store their genetic information as RNA. HIV-1 has three groups: HIV-I major groups (HIV-1 M), outlier (HIV-1 O) and HIV-1 new (HIV-1 N) group.

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HIV is 120 mm icosahedral, enveloped, RNA virus. HIV comprises of an outer envelope consisting of lipid bilayer with uniformly arranged 72 spikes or knobs of gp 120 and gp 41. It also contains enzymes responsible for replication.

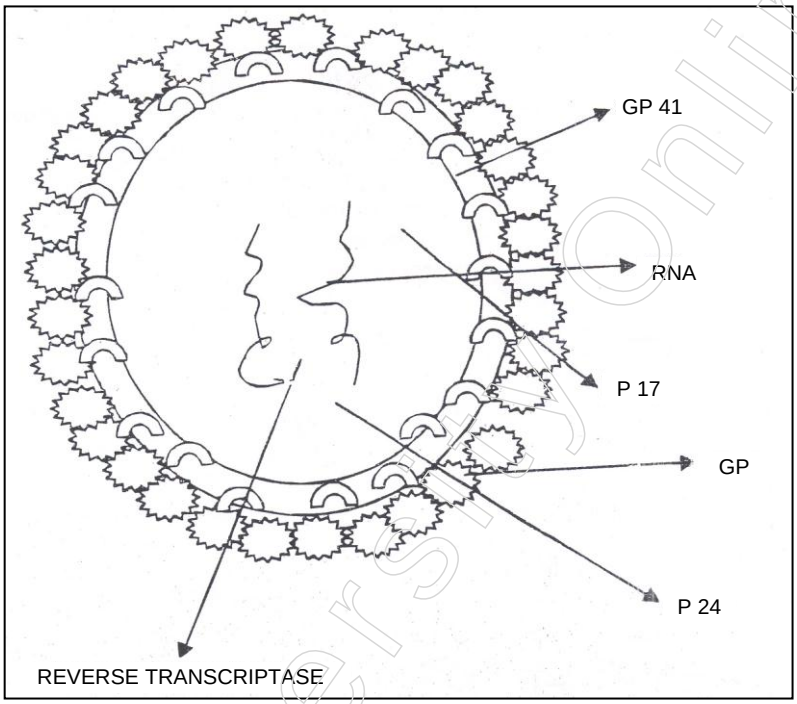

Fig. 6.4: Structure of Virus

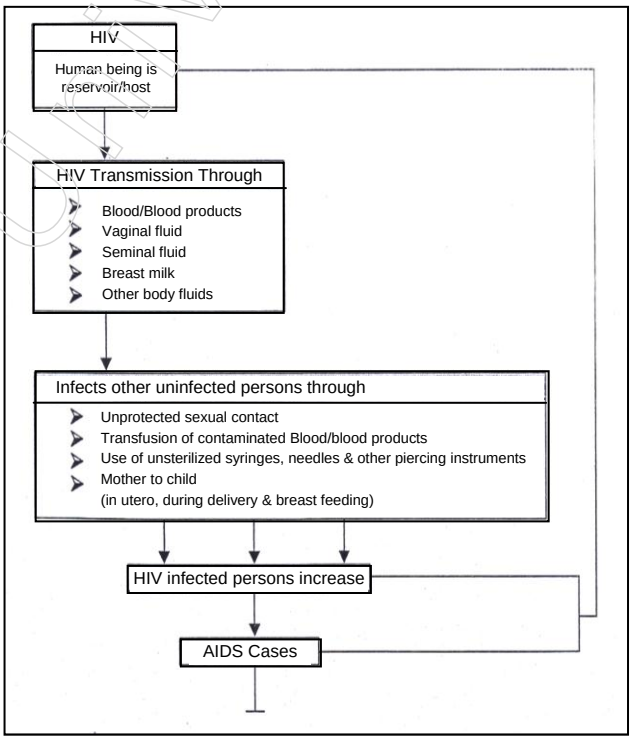

Fig. 6.5: HIV: Transmission Cycle

(c) Amity University Online

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Shaking hands, hugging, dry kissing, sneezing, coughing, mosquito bite, toilet sharing, sharing of telephones, offices, playing, traveling together, sharing cups, living in same room, donating blood aseptically, will not transmit HIV.

6.7 Human Rights

Human rights are the rights that a human being must enjoy on this earth since he/she is a human being. Although the foundation of human rights was laid in the 13th century when resistance to religious intolerance, socio-economic restraints and scientific dogmas resulted in some revolts mainly due to the liberal thoughts of some philosophers. However, true hopes for all people for happy, dignified and secure living conditions were raised with the **Universal Declaration of Human Rights (UNDHR)** by the UNO on **December 10, 1948**. This statement offered complete safety to all people in contradiction of all systems of unfairness and human rights violations. The UNDHR defines specific rights, civil, political, economic, social as well as cultural. It defines the rights to life, liberty, security, fair trial by law, freedom of thought, expression, conscience, association and freedom of movement. It highlights right to equal pay for equal work, right to form and join trade unions, right to health care, education, adequate rest, etc.

Although the human rights are considered to be worldwide, there is an extensive difference amongst the emerging and the advanced nations. Populace and deficiency are frequently found to be the utmost significant reasons of defilement of human rights in the third world countries. Poverty often undermines human dignity, and without dignity, there is no meaning of human right. In fact, talks of human rights seem justified only when one can just manage to live on. ***The World Health Organization estimates indicate that one out of every five persons in this world is malnourished, lacks clean drinking water, lacks proper hygienic conditions and adequate health facilities; one out of three persons does not have enough fuel to cook or keep warm and one out of five persons is desperately poor for whom life is nothing but struggle for survival. Every year 40 million people are dying due to consumption of contaminated drinking water.*** There is severe shortage of jobs in the third world countries. Under such circumstances, a underprivileged man feels that perhaps his child can earn something for himself or the family. For him, the merit of universal education and child labor prevention is of much less importance than his grim struggle for existence.

For the advanced nations, which have by now reached a high phase of growth in physical and financial possessions, the societal and financial rights are not that significant as public and party-political rights. Whereas, the reverse is true for, the developing countries which are struggling far life under conditions of extreme poverty, ignorance, illiteracy, malnutrition and diseases. For them, the civil and political rights carry little meaning. In June 1993, during the **Vienna World Conference on Human Rights**, the need for economic and social rights were considered as equal to the West's political and civil rights. Respect towards human rights is now considered to be one of the important criteria for giving development assistance to a country. In 1992, the Burton Bill passed in USA slashed 24 million dollars of development assistance to same developing countries including India on the grounds of showing poor human rights records.

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6.8 Value Education

Education is a primary feature in bringing about socio-economic and cultural progress of a city. However, the objective of education should not merely be imparting coaching to the students that they get through the examinations with good results and get some good job. Education does not simply mean acquiring a lot of information, but also its righteousness and use within the framework of a spectrum of ethical values.

The rapid strides of technical and scientific progressions have, no doubt, brought radical variations in our everyday lifestyle and information technology has shrunk the whole world into a "global village", with access to very information sitting in one comer over the internet. But, in this frenzy for development and mad race for progress perhaps man has become too materialistic, self-centered and over-ambitious, and the desired ideals of a real good life have been pushed to the background. Value-based education thus has a very significant role in providing proper direction to our youth, to inculcate a positive attitude in them and to teach them the distinction between right and wrong. It teaches them to be compassionate, helpful, peace loving, generous and tolerant so that they can move towards a more harmonious, peaceful, enjoyable and sustainable future.

Value education helps in arriving at value-based judgments in life based on real-world consideration of numerous natural principles rather than getting certain predispositions. Value education includes human values, social values, professional values, religious values, national values, aesthetic values and environmental values. Value education upsurges consciousness about our national history, our cultural heritage, national pride, constitutional rights and duties, national incorporation, civic growth and ecosystem.

Value education has different phases, i.e., value awareness, value orientation, value appraisal, value selection; value commitment and value action. The basic aim is to create and develop awareness about the values, their significance and role. After knowing them, the student's mindset would get oriented towards those values and he will try to critically analyze the same and then select the values which really appeal to him. This will be followed by commitment that needs to be re-affirmed over and over again, that every action is taken keeping those values in view.

Value-based Environmental Education

Ecological schooling or ecological literateness is something that every individual should be well experienced with. The values of biology and basics of atmosphere can really help create a sense of earth citizenship and a sense of responsibility to upkeep for earth and its properties and to be able to sustain it in a manner so that future generations receive a hygienic earth.

We have already discussed about environmental ethics, earth citizenship, and ways and means to propagate environmental education and awareness. **Following the Supreme Court directives (in *M.C. Mehta v. Union of India*, 1988) environmental education has been included in the curriculum right from the school stage to college/university level. The prime objective of the same is to make everyone environment literate.** The environment belongs to each one of us and our actions affect the environment. When the environment gets degraded, it affects our health, well-being and our future. So, we have a right to know the ABC of environment and also have a right to safe and clean environment.

Let us now see how environmental education be made value-based.

1. Preparation of textbooks and resource materials about environmental education can play an important role in building positive attitudes about

environment. The basic human value 'man in nature' rather than 'nature for man' needs to be infused through the same.

2. Social values like love, compassion, tolerance and justice which are the basic teachings of most of our religions need to be woven into environmental education. These are the values to be nurtured so that all forms of life and the biodiversity on this earth are protected. Cultural and religious values enshrined in Vedas like *"Dehi medadami"*, i.e, "you give me and I give you" (Yajurveda) emphasize that man should not exploit nature without nurturing her. Our cultural customs and rituals in many ways teach us to perform such functions as would protect and nurture nature, respect every aspect of nature, treating them as sacred, be it rivers, earth, mountains or forests.
3. Environmental education should encompass the **ethical values** of earth-centric rather than human-centric world-view. The educational system should promote the earth citizenship thinking. Instead of considering human being as supreme, we have to think of the welfare of the earth. **Global values** stress upon the concept that the human civilization is a part of the planet as a whole, and similarly, nature and various natural phenomena over the earth are interconnected and interlinked with special bonds of harmony. If we disturb this harmony anywhere, there will be an ecological imbalance leading to catastrophic results.
4. **Spiritual** values highlight the principles of self-restraint, self-discipline, contentment, reduction of wants, freedom from greed and austerity. All these values promote conservationism and transform our consumeristic approach.

The above-mentioned human values, socio-cultural, ethical, spiritual and global values incorporated into environmental education can go a long way in attaining the goals of sustainable development and environmental conservation. Value-based environmental education can bring in a total transformation of our mindset, our attitudes and our lifestyles. "What is the use of building a beautiful house if you don't have a decent planet to place it on?" – perhaps this single question can answer the main burning question – "What is real development and progress?" We certainly do not want development in exchange of ecological tragedies, well-being dangers, damage of mental peace and merciless destruction of nature's beauty and natural resources. The value basics in ecological schooling alone can prosper in attaining the goals of ecological knowledge.

Health and Human Rights

There are relations amongst the atmosphere, nourishment and well-being that must be seen from a human rights' viewpoint. Correct nourishment and well-being are important human rights. The right to life is an important right in our constitution. As a worsening atmosphere cuts lifecycle, this in outcome has an effect on our important legitimate rights.

Nourishment disturbs and describes the well-being of all individuals, wealthy and underprivileged. It is related to the means by which we produce, grow, work, play, resist contagion, and understand our ambitions as persons, groups and cultures. Deficiency, starvation, undernourishment and badly managed atmospheres together impact well-being and deteriorate the socio-economic growth of a nation. Nearly 30% of people, particularly those in emerging nations, are impacted by this issue. A human rights method is desirable to appreciate and sustain millions of individuals left behind in the 20th century's health revolution. We must safeguard that our ecological standards and

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our vision are linked to human rights and form rules to sustain those that are essential for an improved atmosphere, improved well-being and an improved lifespan.

6.9 Women and Child Welfare

Women and children are usually the soft targets, who suffer in a number of ways mainly because they are weaker, helpless and economically dependent.

Women Welfare

Females typically suffer gender judgment and depression at home, at office, in wedding, in legacy, in civic life and power, predominantly in emerging nations. The gender ferocity, oppression and annoyance take many forms, cross culture, race or nation. The numerical information provided by the Ministry of Women and Child Development is an eye-opener that does not glorify the celebrated culture of our country. The remarkably high number of cases of abduction, dowry deaths, rape, domestic violence, criminal offences and mental torture to women is something that needs instant consideration and improvements in the interest of the women. Women are often the worst victims of communal wars. The human rights of women are violated too often in a male-subjugated male-controlled culture. Thus, there is a crucial necessity for rule improvements and additional strict lawmaking as well as instructive and lawful alertness between women for checking the atrocities and injustice towards her. There are now many **'Women Groups'** who actively take up women welfare issues and legally constituted **"Women cells"** that exist almost everywhere and fight for protection of women rights and dignity. There is a full-fledged Ministry for Women and Child Development whose sole aim is to work for the welfare and upliftment of women encompassing family planning, healthcare, education and awareness. There is a need for complete transformation and reorientation of social ethos for restoring the dignity, status, equality and respect for women.

Women are also the victims of capitalism, development and environment. The exploitative nature of capitalist development not only affects the natural environment but the traditional, social, cultural and family life of women. After losing the forests and getting rehabilitated from their native places, menfolk usually migrate to towns in search of some job while the women are left behind to look after the family and household with little resources. Development projects, like mining, very often play havoc with the life of women. Men can still work in the mines or migrate to towns after getting compensation from the government. The **National Network for Women and Mining (NNWM)** with about 20 groups in different mining states of India is rightly fighting for a **"gender audit"** of India's mining companies. The displaced women are the worst affected as they do not get any compensation and are totally dependent upon the males for wages. The displaced women driven out from their land-based work are forced to take up marginalized work which is highly unorganized and often socially humiliating. Issues related to their dignity and honor have not yet received any attention. The NNWM is now working for rights of women over natural resources, resettlement and compensation issues.

Besides the government initiatives, there are now a number of non-government organizations (NGOs), mostly as **"Mahila Mandals"** to create awareness amongst women of remote villages even to empower them, train them, educate them and help them to become economically self-dependent.

On an international level, the **United Nations Decade for Women (1975-85)** witnessed inclusion of several women welfare-related issues on international agenda. The **CEDAW (International Convention on the Elimination of All Forms of**

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Discrimination against Women), 1979 has been a landmark outcome of the decade to be accepted as an international standard for the protection and promotion of women's human rights and socio-economic upliftment. It is, however, most important for all women, in the mainstream, tribal people, refugees and the downtrodden to be educated about these issues.

Child Welfare

Children are considered to be the possessions of the world. But, ironically, the statistical figures tell us that about a million babies, out of 21 million born every year in India are abandoned soon after their birth due to different socio-economic reasons. Around 20 million children in our country are estimated to be working as child labors, some of them in various hazardous industries like the match industry, firework industry, brassware industry and pottery industry. Poverty is the main reason to drive these children into long hours of work in miserable, unhealthy conditions, and yet they do not get the minimum nutritive food, what to talk of educational and recreational facilities, which are their childhood rights.

The UN General Assembly in 1959 adopted the **Declaration of the Rights of a Child**. After the UN Convention on Rights of Child, it became **International Law** in the year 1990, consisting of 54 articles, and a set of global values and actions to encourage and defend the security of kids in the world.

The law defines right of the child to survival, protection, development and participation. The right to survival emphasizes on adequately good standards of living, good nutrition and health. The right to protection means freedom from mistreatment, manipulation, cold-hearted treatment and abandonment. The right to development ensures access to education, early childhood care and support, social security and right to leisure and recreation. The right to participation means freedom of thought, conscience and religion, and appropriate information to the child.

The **World Summit on Children**, held on September 30, 1990, had a focused agenda for the well-being of the children targeted to be achieved in the beginning of the new millennium. India is also a signatory to the **World Declaration on survival, protection and development of children**. A national plan of action for children has been formulated by the **Ministry of Human Resource Development (MHRD)**, Government of India in which a strategic plan has been formulated for children's welfare in the priority areas of health, education, nutrition, clean and safe drinking water, sanitation and environment. Universalization of effective access to at least primary level schooling, special emphasis on girl child's education including health and nutrition, upgradation of home-based skills, mid-day meals scheme, and expansion of early childhood expansion actions counting in affordable family-based participations are some of the significant movements imagined.

Children are also the most affected due to environmental pollution. *"They consume more water, food and air than adults, hence more susceptible to any environmental contamination,"* says one of the scientific reports of Center for Science and Environment (CSE), New Delhi. Water-borne diseases are the biggest threat to children, affecting around 6 million children in India. Childhood cancer rates are also increasing by 6% every year. Even the growing fetus in the mother's womb is not safe and free from the adverse effects of environmental toxins. It is high time to work together for a secure and cleaner environment so as to give our children a cleaner and safer world to live in.

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6.10 Role of Information Technology in Environment and Human Health

Information technology has tremendous potential in the field of environmental education and health as in any other field like business, economics, politics or culture. Development of internet facilities, World Wide Web, Geographical Information System (GIS) and information through satellites has generated a wealth of up-to-date information on various aspects of environment and health. A number of software have been developed for environment and health studies which are user-friendly and can help an early learner in knowing and understanding the subject.

Database

Database is the collection of interrelated data on various subjects. It is usually in computerized form and can be retrieved whenever required. In the computer, the information of database is arranged in a systematic manner that is easily manageable and can be very quickly retrieved. The Ministry of Environment and Forests, Government of India has taken up the task of compiling a database on various biotic communities. The comprehensive database includes wildlife database, conservation database, forest cover database, etc. Database is also available for diseases like HIV/AIDS, Malaria, Fluorosis, etc.

National Management Information System (NMIS) of the Department of Science and Technology has compiled a database on Research and Development Projects along with information about research scientists and personnel involved.

Environmental Information System (ENVIS): The Ministry of Environment and Forests, Government of India has created an Information System called Environmental Information System (ENVIS). With its headquarters in Delhi, it functions in 25 different centers all over the country. The ENVIS centers work for generating a network of database in areas like pollution control clean technologies, remote sensing, coastal ecology, biodiversity, western ghats and eastern ghats, environmental management, media related to environment, renewable energy, desertification, mangroves, wildlife, Himalayan ecology, mining, etc. The National Institute of Occupational Health provides computerized information on occupational health, i.e., the health aspects of people working in various hazardous and non-hazardous industries, safety measures, etc.

Remote Sensing and Geographical Information System (GIS)

Satellite imageries provide us actual information about various physical and biological resources and also to some extent about their state of degradation in a digital form through remote sensing. We are able to gather digital information on environmental aspects like water logging, desertification, deforestation urban sprawl, river and canal network, mineral and energy reserves and so on. Geographical Information System (GIS) has proved to be a very effective tool in environmental management. **GIS is a technique of superimposing various thematic maps using digital data on a large number of interrelated or interdependent aspects.** Several useful software have been developed for working in the field of GIS. Different thematic maps containing digital information on a number of aspects like water resources, industrial growth, human settlements, road network, soil type, forest land, crop land or grassland, etc. are superimposed in a layered form in computer using software. Such information is very useful for future land-use planning. Even interpretations of polluted zones, degraded lands or diseased cropland, etc. can be made based on GIS. Planning for locating suitable areas for industrial growth is now being done using GIS by preparing **Zoning Atlas**. GIS serves to check unplanned growth and related environmental problems. Our

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satellite data also helps in providing correct, reliable and verifiable information about forest cover, success of conservation efforts, etc. They also provide information of atmospheric phenomena like approach of monsoon, ozone layer depletion, inversion phenomena, smog, etc. We are able to discover many new reserves of oil, minerals, etc. with the help of information generated by remote sensing satellites. Thus, remote sensing and GIS play a key role in resource mapping, environmental conservation, management, planning and environmental impact assessment. It also helps in identifying several disease infested areas which are prone to some vector-borne diseases like malaria, schistosomiasis, etc. based upon mapping of such areas.

There are several **Distribution Information Centres** (DICs) in our country that are linked with each other and with the central information network having access to international database.

www (World Wide Web): A vast quantum of current data is available on **World Wide Web**. One of the most important online learning centers with power web is www.mhhe.com/environmental science and multimedia Digital Content Manager **(DCM)** in the form of CD-ROM provides the most current and relevant information on principles of environmental science, various problems, queries, applications and solutions.

The World Wide Web with resource material on every aspect, classroom activities, digital files of photos, PowerPoint lecture presentations, animations, web exercises and quiz has proved to be extremely useful both for the students and the teachers of environmental studies.

The role of online1earning center website has the following features:

(a) Student-friendly Features: These include practice quiz, how to study tips, hyperlinks on every chapter topic with detailed information, web exercises, case studies, environment maps, key terms, career information, current articles, interactive encyclopedia and how to contact your elected officials.

(b) Teacher-friendly Features: These include in addition to above supplement resource charts, additional case studies, answers to web exercises, solutions to critical thinking questions, editing facility to add or delete questions, create multiple versions of same test, etc.

Information technology is expanding rapidly with increasing applications and new avenues are being opened with effective role in education, management and planning in the field of environment and health.

6.11 Summary

Global human population is expected to cross the seven billion mark by 2015. The needs of these huge number of human populations is difficult to be supported without degrading the quality of life. The increasing pressure on resources places greater demand on buffering action of nature. In India, the government took up effective family welfare programmes, but it has still not become very effective. The greatest challenge they would face is how to supply the resources it requires. Potable water is already in short supply. Soil has become unproductive. The air pollution problem in mega cities is already threatening the health of the people living there. The number of poor people living in urban areas is increasing. They live in slums and suffer from insanitary conditions.

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6.12 Check Your Progress

I. Multiple Choice Questions

1. What is the main problem in economic development?
   (a) Decrease in agricultural income
   (b) Population growth
   (c) Decrease in rainfall
   (d) Increase in unemployment

2. To prevent poverty in India, we have to _____.
   (a) Store more water
   (b) Create unemployment opportunities
   (c) Stop rapid privatization of industries
   (d) Prevent population growth
3. Universal Human Rights proclamation was published in the year _____.
   (a) 1908
   (b) 1950
   (c) 1948
   (d) 1998
4. For ideal culture and creation of society, _____.
   (a) value education is necessary
   (b) high education is necessary
   (c) business is necessary
   (d) technology is necessary

6.13 Questions and Exercises

1. Explain population explosion with reference to Indian scenario.
2. Discuss the influence of environmental parameters and pollution on human health.
3. Write short notes on:
   (a) Doubling time
   (b) Child welfare
   (c) HIV/AIDS
   (d) Role of IT in environment
4. What do you understand by population stabilization? Discuss.
5. Write a brief account on importance of Human Rights.

6.14 Key Terms

- **Population explosion:** Exponential growth of population to a size that exceeds the carrying capacity.
- **Rehabilitation:** Re-establishing the outsees or restructuring the ecological system that has been degraded.
- **Unionization:** Increasing concentration of population in cities.
- **Zero population growth:** When births and migration in a populace equals deaths and emigration.

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- **UNEP:** United Nations Environment Programme.

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6.15 Check Your Progress: Answers

I. Multiple Choice Questions

Question	Answer
1	(b)
2	(d)
3	(c)
4	(a)

6.16 Further Reading and References

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Module V: Biodiversity

Unit VII: Biodiversity

Structure:

Objectives

After studying this unit, you should be able to:

- Define genetic species and ecosystem diversity
- Understand bio-geographical classification of India and values of biodiversity
- Know about hotspots of biodiversity and differences between endangered and endemic species
- Discuss conservation of biodiversity

7.1 Introduction

If we divide the whole earth's mass into 10 billion parts, it is only in one part where life exists and the astounding diversity of alive creatures numbering somewhere around 50 million species are all restricted to just about a kilometre – thick layer of soil, water and air. It is wonderful to see that so much diversity has been created by nature on this earth from so little physical matter. Biodiversity refers to the variation amongst all groups of living organism and the ecosystem complexes in which they occur.

Biodiversity is the shortened form of two words – "biology" and "diversity". It states all the varieties of life which can be found on earth (animals, plants, fungi and microorganisms) as well to the groups that they form and the environments in which they live.

The human race has evolved with time. It is considered technologically advanced society. Today, our knowledge of nature has increased with the research in the area of Biology, Life Sciences, Microbiology and Chemistry. The plants, insects, animals and the microorganisms living on land, in air and in water together constitute our world. The

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health of the environment is vital for the existence and survival of human race. It is this complex collection of innumerable organisms. That makes our lives worth living. Scientists believe that the entire amount of species on earth is between 10 to 80 million. With all our development, we know only 1.4 million species so far. Nature has created this complex spectrum of life on the planet with 600 million years of experimentation. It is a sad story that our great heritage is disappearing at very fast rate not planned by nature for improvization but by man to fit the overpopulation. This reduction in biodiversity can be dangerous for the whole world.

We, in India, traditionally respected plants and animals – flora and fauna. We knew the interdependence of living organisms and changing living conditions – ecosystems. **The principle of 'live and let live' was practiced.**

Concept and Values of Biodiversity

Biodiversity refers to the variety or variations amongst clusters of living organisms and the ecosystem.

It is the differences within the world of plants, organisms and animals and their co-existence.

Biodiversity Definition Given in 1992 UNO Convention at Rio

The changeability amongst living organisms from all foundations including *inter alia* terrestrial, marine and other aquatic ecosystem, and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. It is the mark of diversity in nature.

Biological resources involved genetic resources, organisms or part of biotic component of ecosystems with value for humanity.

Biotechnology is the technological application using bio-system or living organism to modify products for use.

Sustainable use is a use of biological diversity in a way that does not result in weakening of bio-resources. Hence, it can preserve the needs of present generations as well as future generations.

From the deserts of Rajasthan to dense rainforests of Darjeeling, from high snow-clad mountain peaks of Himalaya to the deepest of ocean trenches of Andaman and Nicobar Islands in India, life occurs in a beautiful spectrum of forms, sizes and colors which makes India the 12th "Mega Biodiversity" country in the world. With only 2.5% of the landmass in the world, it possesses 7.8% of the recorded species.

The bio-cycle is the cycle of each species depending on another for existence, e.g., the rats in the fields eat insects, which in turn are swallowed by snakes, which in turn are devoured by birds.

The levels of Biodiversity may vary from genetic level within a species to the biota in the specific region and can extend into great diversity band in different zones.

Biodiversity aspects are described with respect to three **fundamental and hierarchically related levels of biological organisms:**

1. Genetic diversity (Diversity within species)
2. Species diversity (Diversity between species)
3. Ecosystems diversity

1. Genetic Diversity: This is an elementary foundation of differences in organisms. The genes can form massive amount of combinations, each of which gives rise to some variety or variability. Genes are basic units of

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hereditary information transmitted from one generation to another. Apart from shape and size, the characteristics such as resistance to insects or diseases or ability to withstand adverse environmental conditions, when the genes within the same species show different versions due to combinations, it is called genetic variability or diversity. A species with a large number of races, strains or varieties is considered to be rich and diverse in its genetic makeup. This is very important for practical benefits.

2. **Species Diversity:** This is the variation found within the population of a species or between different species of a community. It explains the species richness and abundance in a community.

   Species means a term used by biologists and ecologists to specify the unit for like type of organisms. It also refers to variety of species within a region. This could be measured on the basis of total number of species. Thus, it is possible to count number of species at any given sample site. If a focus is kept on say birds, animals, etc., it is possible to estimate the population density at a location. The organisms interact with one another and affect the environment.

3. **Ecosystems Diversity:** These variations are based on ecological complexity showing differences in ecological niches, food webs, tropic structure, nutrient cycling, etc. Thus, the ecosystem develops its own distinctive community of living organisms. A small pond, for example, has an ecosystem with a set of flora and fauna different from river water. Different types of forests, grasslands, lakes, ponds, rivers, wetlands, etc., each have its own biotic community. The physical parameters such as moisture, temperature, altitude, precipitation, etc. may result in variations. From tropical rainforests, deciduous forests to bio-real forests, there are incredible differences. This, as a result of evolution of millions of years, has affected the balance of ecology and caused disturbance, which can further spell a disaster.

The assessment of Biodiversity is carried out by taking inventory from land mass ecosystem by remote sensing, taxonomic survey, point or visual survey. This can be done by selecting high impact species such as useful, threatened, endangered, extinct, etc. A broad scale sampling or size population survey can also lead to genetic variations.

After the 'Earth Summit' at Rio in 1992, it has become important to know the scientific names of the species. Till date, about 1.5 million species are known of which 15% may be recorded. These has beneficial impact – Plants with medicinal properties such as Neem tree has now global impact; Cam plant has magical effect on HIV virus.

Silent Valley of Kerala in India is known for tropical rainforests. Globally, there are estimated 1,70,000 flowering plants, 30,000 vertebrates and 2,50,000 other species.

Table 7.1: Plants and Animals (Living Species Estimate)
World Resource Institute, 1999

Taxonomic Group	Number
Bacterial and Cyanobacteria	5,000
Protozoans (Single-celled Animals)	31,000
Algae	27,000
Fungi (Molds and Mushrooms)	45,000

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Plants (Higher Variety)	2,50,000
Jelly Fish and Corals	10,000
Worms (Flat, Round and Earth)	36,000
Insects	7,50,000
Mites, Ticks, Shrimps and Croaks	1,20,000
Fish – Sharks	22,000
Amphibians – Reptiles	10,000
Birds	9,000
Mammals	4,000
Sponges	5,000
Reptiles	5,000
Amphibians	4,000
Snails, Dams and Slugs	70,000
Total	1,400,000

Table 7.2: Distribution of Species in Some Major Groups of Flora and Fauna in India

Plants	Number	Animals	Number
Algae	2500	Mollusks	5042
Bacteria	850	Lower Groups	9979
Bryophytes	2564	Arthropoda	57,525
Gymnosperm	64	Pisces (Fishes)	2546
Angiosperms	15,000	Amphibian	428
Pteridophytes	1022	Reptiles	1228
Fungi	25,000	Birds	204
		Mammals	372

7.2 Value of Biodiversity

The utility, eco-services, societal and appealing value of Biodiversity — commercially, is extraordinary. In our society, we call this as sacred plants or animals. It influences agriculture, livestock, forestry, fishery, etc. which generates 30% of the national income. The benefits are at global level, country specific and for local area requirement.

At the local level, people desire direct benefit from plants, crops, and wildlife species. This protects the equilibrium. If uncontrolled, the destruction of biodiversity can be a great loss to mankind.

The Biodiversity value has been classified as follows:

1. Consumptive use:
   (a) Food
   (b) Drugs and medicine
   (c) Fuel

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2. Productive use
3. Social value
4. Ethical value
5. Aesthetic value
6. Unknown uses
7. Ecosystem services.

1. **Consumptive Use:** The Biodiversity product can be harvested and consumed directly, i.e., direct application.
   (a) **Food and Farm Fruits:** Grains, vegetables, nuts, tea, coffee, oil plants, wheat, fish, eggs, milk, honey, etc. There are about 80,000 edible plants. There exists a relation from wild to real use. The wild species of plants are related to crop plants. Hence, hardy strains are developed which possess better tolerance and hardiness.
   (b) **Drugs and Medicines:** About 75% population of the world is dependent on plants and their extracts. The modem drug Penicillin was derived from fungus called Penicillium. It was a miracle antibiotic. We get tetracycline from bacterium.

   The cure for Malaria by Quinine is obtained from bark of Cinchona tree. The hair-curing drug Digitalis is obtained from *Digitalis Foxglove*. The Catharanthus plant is responsible to give two anti-cancer drugs called Vinblastine and Vincristine. Huge number of aquatic animals also possess such properties.
   (c) **Fuel:** The wood is used as fuel for centuries. The fossilized Biodiversity give us fossil fuel petroleum and natural gas.
2. **Productive Use:** In this, there is marketable product which is sold commercially. It could be a specific gene for crops on domesticated animals. The animal products such as elephant tusks, musk from deer, silk from worms, wool from sheep and lac from lac insects. The paper industry, silk industry and ply, leather and pearl industry are the examples of large-scale commerce. Some of the products, despite a ban on them, are still sold as it gets good revenue.
3. **Social Value:** The society recognizes certain customs among a group as a tradition, Tulsi (Holy basil), Peepal, Mango, Lotus, Bael, etc. The plants, fruits and leaves are all worshipped. The social, folk, dance, songs and customs are testimony of the social value of biodiversity. In spiritual religious world, some animals also dominate, e.g., cow, snake, bull, owl, peacock, etc.
4. **Ethical Value:** "Live and let live" is the principle behind survival of human race and hence survival of biodiversity. The pigeon used for postal delivery as well as beautiful looking 'dodo' are with now no more as they are 'Extinct'. But we still feel that Kangaroo, Zebra or Giraffe must live for ethical reasons.
5. **Aesthetic Value:** Eco-tourism, where there is wilderness, wide stretch of land to see but nothing else, still attracts tourists from the world over. The 'Grand Canyon' and 'Bad Lands' in USA are the examples. It earns more than $10 billion, valuing the revenue every year.
6. **Unknown Uses:** Future wealth in marine ecosystems, there may exist a potential cure for cancer or HIV, i.e., AIDS. This can be a precious gift. There are options to visit and to see some endemic, rare or endangered species.
7. **Ecosystem Applications:** These are also called indirect applications, e.g., photosynthesis, water cycles, pollination, soil erosion, protection from floods,

droughts, and calamities, balancing of nitrogen, oxygen or carbon cycles, climatic changes and reduction of threat from global warming.

Biodiversity Value of Some Selected Organisms in Monetary Terms (Economical Aspects)

- Tourism to **Great Barrier Reef** in Australia earns $2 billion each year.
- In its lifetime, a **Kenyan elephant** can earn worth $1 million as tourist revenue.
- Whale watching on Hervey Bay on Queensland's coast earns $12 million annually.
- The **mountain gorillas in Rwanda** are fetching $4 million annually through eco-tourism.
- A typical tree provides $196,2150 worth of ecological services as oxygen, clean air, fertile soil, erosion control, water recycling, wildlife habitat, toxic gas moderation, etc., whereas, its worth is only about $590 if sold in the market as timber.
- A male lion living up to an age of 7 years can generate up to $515,000 due to its aesthetic value as paid by tourist, whereas if killed for the lion skin, a market price up to $1,000 can be fetched.

Additional Information on Importance of Biodiversity

Biodiversity (Biological diversity) has straight consumptive value in food, agriculture, medicine and industry. It has aesthetic and recreational worth. Biodiversity maintains the ecological balance and continuous evolutionary processes. Importance of diversity is explained as **economic importance.**

Medicine: Both, traditional medicines and processed drugs are gained from Biodiversity. Penicillin is found in **Mold**, Codeine is obtained from **Poppies**, Digitalis from **Foxglove** and Quinine from the bark of **Cinchona**.

Fuel: Timber, coal, oil and natural resources are used to produce energy.

Shelter and Warmth: Timber and other forest products are used as building materials and for shelter. Fibers such as wool and cotton are used to make clothes.

Food: Species are hunted (birds, antelopes), fishes (cod, tuna fish) and gathered (fruits, berries, mushrooms) as well as cultivated for agriculture (wheat, corn, rice, vegetables) and agriculture (salmons, mussels). It is important to know that of the 800,000 useful plants available, humans use very less to satisfy 90% of our planet's elementary needs.

7.3 Ecological Importance

- Insects, bats, birds and other animals serve as pollinators.
- Trees provides habitat and food for birds, insects, other plants and animals, fungi and microorganisms.
- Green plants take in CO_2 from atmosphere and replenish it with oxygen.
- Forests are particularly "sink" for the absorption of CO_2 and the key factors in reducing global climatic change.
- Parasites and predators act as natural population controls.

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Indirect Services

Pollination: Insects, birds, and bat species transmit pollen grains from plant to plant or else from one portion to another portion of plant, thus fertilizing fruits, crops and flowers.

Cultural Importance: Different species of flora and fauna is frequently used as symbols in flags, or in painting portraits, statues, pictures, imprints, or referred to in songs and stories. Finally, Biodiversity also has an aesthetic appeal. It is a visual artistic pleasure to see and smell flowers in a field or to listen to bird's singing.

Fertile Soil: Microorganism recycle the soil's organic matter and maintain its **fertility.** Plants absorb CO_2 **from the atmosphere and convert it into oxygen**, thus providing us with air to breath.

Clean Drinking Water: Only a small amount, about 1% of the water in our planet is usable directly. The rest is either salty (97%) or frozen (2%). Forests around the world filter out usable water again and again, constantly replenishing the water for drinking and bathing and growing crops.

Biodiversity for Sustenance of Mankind

Biodiversity solely withstands the environment globally. In limited sense, products which man needs for the survival are well recognized. Medicine, cultural, utility values, etc. are commercially exploited.

The drugs manufactured from plants, fungi, bacteria and animals are marketed at 2000 million dollars per year. Loss of a tree a day means expenses worth 600 million dollars/year. The hormones, enzymes and food products are all established in world markets.

Though extinction or elimination of a species is a natural process of evolution, some die and others get replaced. The speed of such situations happening is dreadful. It is now recognized that, the ecosystem, which is sustaining mankind, is reacting to the foolish actions, narrow view to achieve more economic mileage and overutilization of resources by humans. Nature cannot provide at the rate of which the loss is occurring. Hence, several natural calamities take place.

Biodiversity as a resource must be utilized with extreme carefulness and correct information of preservation and protection. The knowledge of management of biodiversity must be applied, e.g., regulation of access and creation of heritage sites. Every step should be taken to prevent this trend of extinction of 10,000 species per year, i.e., 27 existing beings every day.

Resource Limitations

The aim of 'Biological Diversity' resolutions has been to prevent gradual of loss of Biodiversity. The attack was threefold: **conservation, protection** and **sustainable consumption**.

The policy decisions were finding technology transfer and local resource mobilization. But the social, economical and political diversity amongst the wealthy and underprivileged shifted the balance of ecology. The financial help started diminishing. The poor have to produce more and sell at cheap rates to survive. The overuse of land, and use of fertilizers, chemicals and pesticides to protect the crop lead to the killing of biodiversity.

The losses are global in nature. Since then, there are concerns for climatic changes and its after-effects.

Ecological Role of Biodiversity

The characteristics of ecosystems are such that it has an integral combined effect on pattern of biodiversity. From the records presented by fossils, it is clear that under stress, some species have a constant life span. The probability that a particular species will become extinct within a certain time, after it split off as a new species, is approximately constant.

This is due to combined manifestation of biotic and environmental factors. The diversification, as a function, is related to energy flow and recycling – more the complexity less energy it needs.

Environment is a part of nature which comprises a group of life-forms and their physical atmosphere.

The functions of ecosystem are flow of energy, nutrient recycling, self-regulation and interdependence.

Each species has a significant part in keeping the eco-environment alive. Biodiversity is responsible for increased productivity, e.g., soil Fertility is preserved by biological variations. Removal or addition of species are important because it changes the population and hence performance of other species. Thus, rich biodiversity is important. This also gives strength and security against man-made or other calamities. It ensures survival at all cost, e.g., Tambadi variety of rice can even withstand severe drought. **The variety in biodiversity and richness is must to sustain and maintain ecosystem.**

Interdependence between Different Species

The ecosystems and species are inter-reliant, as they create the habitat in environment. There exists an interdependence between species of diverse kinds. This is reflected in their food space, propagation and protection. The small and weaker breed imitate the strong for existence.

The insects are flower-specific. They have structures suitable for nectar sucking and pollination. The bees, e.g., have to pollinate flowers. In turn, they are rewarded with nectars. Some flowers and petal structures make it easier for the insects to land. The food chains of flora, fauna and microorganisms are related to one another, e.g., rats eat insects in the fields, which are eaten by snakes, and they are further killed by birds.

If one sprays insecticides for killing insects for protection of plants, the impact is reversed and the crop production suffers. The butterflies escape because of colorful wings. In the instinct of survival, each species has been given a defence mechanism. If the link in the cycle breaks, it gives rise to cascading effect that everyone in the cycle suffers.

7.4 India as a Mega-Diversity Nation

Amongst the 12 mega biodiversity countries in the world, India is one of them. The biological wealth is distributed in ten broad biological zones. Each one has its own biota (characteristic). The survey conducted on 75% of the area indicates that there are about 47,001 plants and 81,000 animal species. This represents 7% of the world flora and equal amount of fauna (here, 6.5% of fauna).

Endemism: India has a large number of endemic species, i.e., 62% of amphibians and 50% of lizards are prevalent, which are restricted in location. One can observe maximum endemism at the sites of Western Ghats.

Notes

Centre of Origin: Out of all the species of flowering plants, approximately 5,000 species had their roots in India. It is the centre of 166 kinds of yield vegetation and 320 species of wild relatives of cultivated crops. It provides broad spectrum of diversity of traits of our crop plants.

Marine Diversity: There are mangroves, creeks, coral ridges, backwaters, along 7,500 kms coastline out of which 350 species of corals are in India.

Biodiversity Hotspot: India has a rich variety of biodiversity. Two of the world's 18 hotspots of biodiversity are found in India.

Species: India has 26 recognized widespread centres. Of the estimated 5.50 million breeds of the world's biota, only a 1.4 million have been engraved and circulation is really irregular.

Biodiversity Centres/Sites: India has achieved one of the 12 positions in the centres of cultivated plants. It has 5 world archaeological locations, 14 environmental funds and 6 Ramsar wetlands.

Protected Area: The total protected area is about 3.16 million km^2 (4.4% of geographical area).

Aquatic Ecosystems: The country has extensive ecosystems with a marine habitat extending over 7500 km of its coastlines.

Plant Species: Out of the total 49,219 vegetal kinds, 5,150 are extensive and scattered into 141 types beneath 47 families conforming to approximately 30% of the biosphere's verified flora, i.e., 30% of the world's documented flora are widespread in India.

Animal Species: With 81,251 animal species, India accounts for 6.67% of the world's total fauna population.

Agro Biodiversity: India's record in Agro Biodiversity is equally impressive. There are 166 crop species and 320 wild relatives. India is seventh in terms of contribution to world agriculture.

Table 7.3: Comparison between Number of Species in India and Rest of the World

Group	Number of Species in India (SI)	Number of Species in the World (WI)	SI/WI%
Mammals	350	4629	7.6
Birds	1224	9702	12.6
Reptiles	408	6550	6.2
Amphibians	197	4522	4.4
Fishes	2546	21,730	11.7
Flowering Plants	15,000	250,000	6.0

The current apprehension for damage of ecosystem is replicated in India joining the agreement in 1994.

7.5 Bio-Geographical Classification of India

1. North-Western
2. Western Himalaya
3. The Plain of Ganga
4. Central India

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Notes

5. Deccan Plateau
6. Chota Nagpur Plateau
7. Western Ghats
8. North-Eastern region
9. Andaman and Nicobar Islands.

1. **North-Western Desert (North-Western):** Cactus, Khijri tree and bushes, 43 types of reptiles, large numbers of insects and camels, black bucks, Nilgirigai, Fox, Indian bustard, Chinkara, cats, etc.
2. **Western Himalaya:** In the glaciers and rocks, sheep, goats and leopards are found. About 5,000 trees bloom with flowers. Acacia, Sal and Simul trees are important; so are oak, chinar, walnut and poplar. There are varieties of monkeys, butterflies, tigers, deer, snakes, pythons, musk deer and also numerous flower species in the valley.
3. **Plain of Ganga:** Yamuna, Gandak and Mandakini are tributaries. The soil is fertile and home for Tiger, Panther, Elephant, Turtles, Fish, etc. In Bengal, in Sundarban forests, one finds the famous stripped Bengal Tiger.
4. **Central India:** The mountains of Satpura and rivers are famous for dugong, dolphins and crocodiles. Lakshadweep has 36 major birds. These are 12 atolls, 3 reefs and 5 submerged corals. One can find there 4 species of turtles, 36 species of crabs, 12 bivalves and 41 species of sponge.
5. **Deccan Plateau:** The soil is volcanic and fertile. Teak trees are in this region. Bison, Barasinga deers, leopards, monkeys, rabbits, peacocks, eagle, hola and falcons are found here.
6. **Chota Nagpur:** Fifty per cent of land is covered with forests. Teaks, Sal, Bamboo and Lac trees are from this region. Deer, Sambar, Bison, Tiger and Wild boars are also found.
7. **Western Ghats:** The Ghat covers 5% of land surface, but is home for more than 4,000 of the varieties of plants, of which 1,800 are pervasive.
8. **North East:** It is divided into Eastern Himalaya to Zone between India, Malaysia, China, Assam, Nagaland and Imphal. It has rainforests, monsoon forests, swamps and grasslands. There are 390 plant species, of which 63% are in Assam.
9. **Andaman & Nicobar Island:** These are the group of 325 Islands. Rainfall is very heavy. There are 2200 species of plants recorded, of which 200 are widespread.

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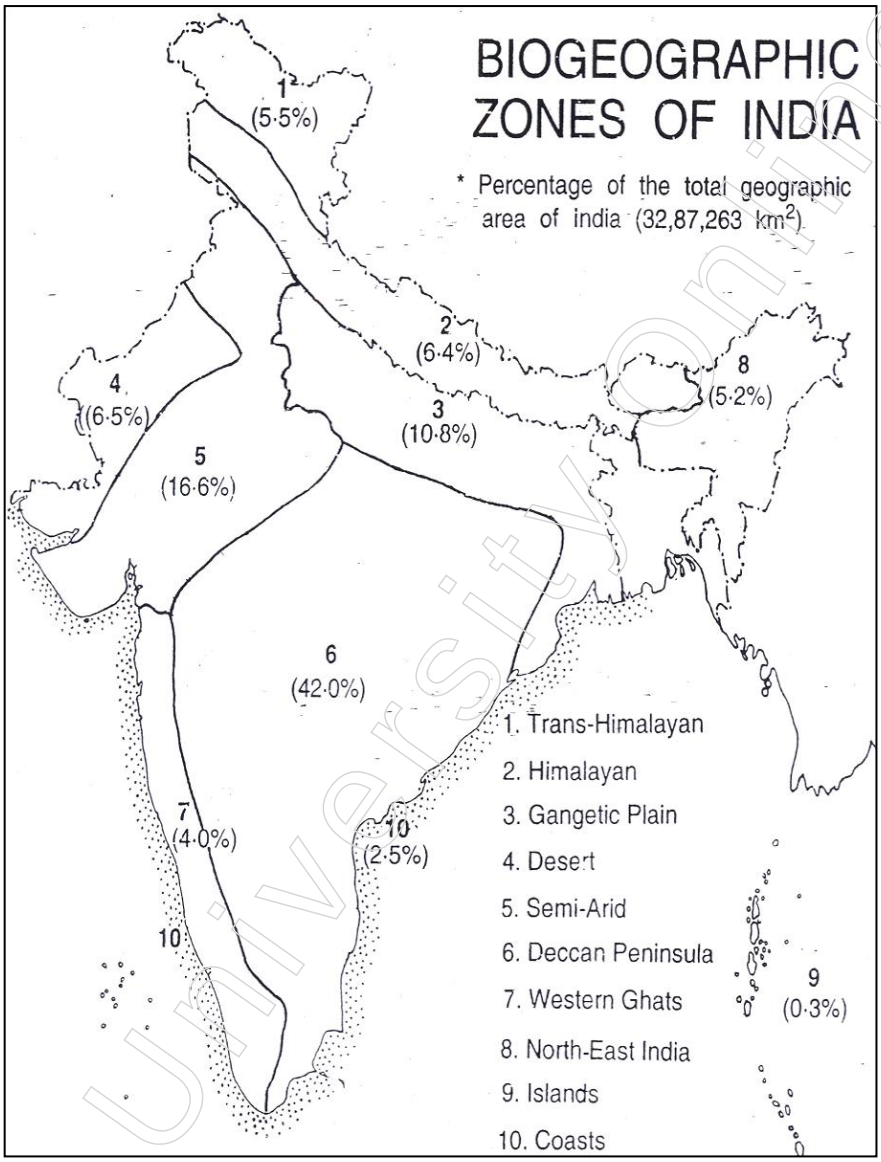

Map 7.1: Bio-geographic Zones of India

Economical Potential of Biodiversity

Plants and animals have been exploited by man since ancient times. Food, clothing and housing, and numerous beneficial products arise from diversity of life-forms. Organic variety is a treasured natural reserve on the survival of human race. Loss of biodiversity possibly will affect in vanishing of species that have economic value.

About 1.5 million plant species have been documented. Out of these, about 2,500 plants have been cultivated. From 2,50,000 plants, about 25,000 plants have been studied in some details. The biotic prosperity so far on accounts signifies a massive source essential to be appointed for existence.

Biotechnology is a science of Engineering, the biological products by producing, modifying or finding them useful for humanity. The genetic material of flora and fauna can be suitably modified to add value. Thus, a company with knowledge of biotech component of a product gets the upper hand in the market. This mechanism has a multiplied effect and the product cost rises to astronomical amounts.

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Global trade in the forest products is worth 150 billion USA dollars every year. The market share in cotton product alone is 30 billion US Dollars per year.

The products identified for place in the world market are as follows:

Table 7.4: Commercial Products

Products	Market Amount (in Million Dollars)
Environmental products, enzyme industry or detergents, textile and bio-catalysts	Projected growth of 50 next year
Health-care related	Projected 20%
Bio-materials, forest and cotton	Considered invaluable for next decade

Non-Wild Life Conflict: Extinction and Loss of Biodiversity

Speciation and extinction are natural processes. Traditionally, from the Darwinian perspective, extinction is the fate of species which lose in the struggle for survival. But habitat loss due to human intervention for various reasons are the prime concern for species' extinction. In fact, there is no precise extinction of the numbers of species which are being lost over the decades. The reasons are very simple—in fact, there was no estimate of actual species member in each category earlier and vast majority of the species are not monitored. Only the larger plants and animals were mostly monitored for over past couple of decades.

The major causes of extinction of species are:

- Habitat destruction
- Hunting of wildlife
- Introduction of new species
- International trade of biotic resources
- Pollution of various habitats
- Catastrophic processes
- Several other accidental causative

It is very interesting to note the fact that the growth of human population is paralleled by the increase in the extinction rate of birds and animals. There were some assessments made to assess the relative importance of various extinction factors on the disappearance of mammals and birds. On the whole, habitat destruction followed by hunting appears to be the major threat of extinction.

Considering the relative importance of the threat of species extinction, IUCN categorized six major classes of threatened species as incorporated in their "Red Data Book". This categorization involves both flora and fauna as exists in their wild habitats. The priority of conservation of various species is thus made on the basis of their relative threat potentialities.

IUCN (i.e., WCU)

Objectives

To highlight the legal status of rare species for the purpose of conservation, the International Union for Conservation of Nature and Natural Resources (IUCN) recognized earlier in 1963, 1984 and 1988 the following **five** main conservation categories:

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Notes

1. **Extinct:** Species that are no longer known to exist in the wild. Searches of localities where they were once found and of other possible sites have failed to detect the species.
2. **Endangered:** Species that have a high likelihood of going extinct in the near future.
3. **Vulnerable:** Species that may become endangered in the near future because populations of the species are decreasing in size throughout its range.
4. **Rare:** Species that have small total numbers of individuals often due to limited geographical ranges or low population densities.
5. **Insufficiently known:** Species that probably belong to one of the conservation categories but are not sufficiently well known to be assigned to a specific category.

IUCN later (2012) recognized nine Red List categories of species (Fig. 7.1).

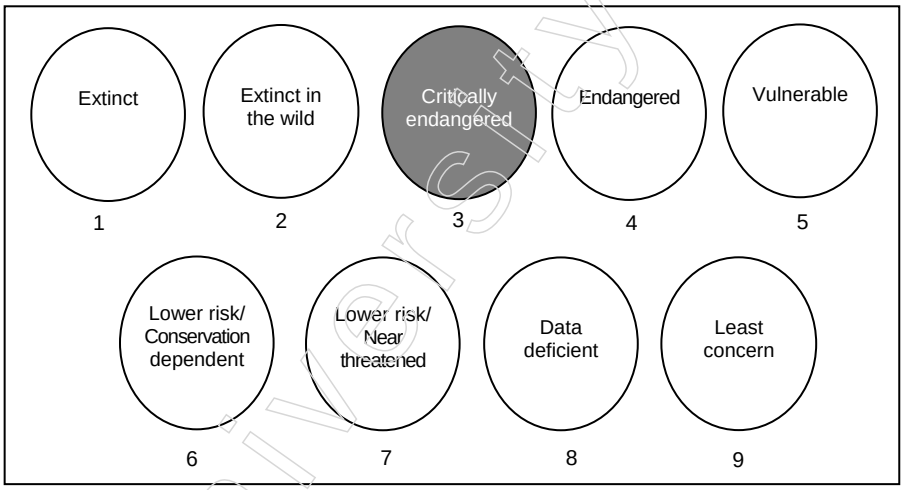

Fig. 7.1: Nine Risk Categories of Species (IUCN, 2012)

Critically Endangered

Critically endangered is the highest risk category assigned by the IUCN Red List to wild species. There are five quantitative criteria to determine whether a taxon is threatened. A taxon is critically endangered when the best available evidence indicates that it meets any of the following criteria:

Objectives

1. Populations have declined or will decrease, by greater than 80% over the last 10 years or three generations.
2. Has a restricted geographical range.
3. Small population size of less than 250 individuals and continuing decline at 25% in three years or one generation.
4. Very small or restricted population of fewer than 50 mature individuals.
5. High probability of extinction in the wild.

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Notes

IUCN Red List Categories

Objectives

IUCN, now known as the World Conservation Union, with headquarters at Gland, Switzerland, is the premier coordinating body for international conservation efforts.

Critically Endangered Animals of India

Zoological Survey of India (ZSI), in its report of the year 2011, has listed 56 species of animals as critically endangered species in India. This included 13 birds, 10 mammals, 6 reptiles, 19 amphibians, 5 fishes, 2 spiders and 1 coral. These are as follows:

Birds:

1. Jerdon's Courser
2. Forest Owler
3. White-bellied Heron
4. White-backed Vulture
5. Slender-billed Vulture
6. Long-billed Vulture
7. Red-headed Vulture
8. Bengal Florican
9. Himalayan Quail
10. Pink-headed Duck
11. Sociable Lapwing
12. Spoon-billed Sandpiper
13. Siberian Crane
14. Great Indian Bustard

Mammals:

1. Pygmy Hog
2. Andaman White-toothed Shrew
3. Jenkin's Andaman Spiny Shrew
4. Nicobar White-tailed Shrew
5. Kandana Rat
6. Large Rock Rat or Elvira Rat
7. Namdapha Flying Squirrel
8. Malabar Civer
9. Sumatran Rhinoceros
10. Javan Rhinoceros

Reptiles:

1. Gharial
2. Hawksbill Turtle
3. Leatherback Turtle
4. Four-toed River Terrapin or River Terrapin
5. Red-crowned Roofed Turtle or Bengal Roof Turtle
6. Sispara Day Gecko

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Notes

Amphibians:

1. Anamali Flying Frog
2. Gundia Indian Frog
3. Kerala Indian Frog
4. Charles Darwin's Frog
5. Kottigehar Bubble-nest Frog
6. Amboli Bush Frog
7. Chalazodes Bubble-nest Frog
8. Small Bush Frog
9. Green-eyed Bush Frog
10. Great Bush Frog
11. Kaikatt's Bush Frog
12. Mark's Bust Frog
13. Munnar Bush Frog
14. Large Ponmudi Bush Frog
15. Resplendent Shrub Frog
16. Sacred Grove Bush Frog
17. Sushil's Bush Frog
18. Shillong Bubble Nest Frog
19. Tiger Toad

Fish:

1. Pondicherry Shark
2. Ganges Shark
3. Knife-tooth Sawfish
4. Large-tooth Sawfish
5. Long-comb Sawfish or Narrow-snout Sawfish

Spiders:

1. Rameshwaram Ornamental or Rameshwaram Parachute Spider
2. Gooty Tarantula, Metallic Tarantula or Peacock Tarantula

Corals:

1. Fire Corals

As per IUCN (2012) report, status of animal species of different categories of threatened species in India has been shown as follows:

Critically Endangered (CR)	–	57 (including 15 birds)
Endangered (EN)	–	310
Birds	–	14
Mammals	–	38
Fish	–	69
Amphibians	–	32
Vulnerable (VU)	–	51

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Loss of Biodiversity Non Animal

Due to rapid disappearance of tropical forests in countries like India, at a rate of about 0.6% per year, it is estimated that tropical forests would disappear within 150 years, i.e., by the year 2000. In the next 20 years, 90% of the forests and 505 varieties of plant species can disappear from the planet, i.e., **one million species may disappear within next 20 years, i.e., by year 2020.**

The loss can be man-made or genetically engineered. There is loss in habitat due to deforestation. The loss can also be due to exploitations of soil, atmosphere pollution and water pollution. Use of fertilizers in aggressive method of agriculture can also be due to snapping out of species to create a stronger more endowed species. **With changes in the environment, the species also require to adopt itself:**

1. **Loss of Habitat and Fragmentation:** The habitat, i.e., the original natural surrounding and its destruction is a major problem. Cutting forests and burning of grass creates fragmentation. The plants, animals and microorganisms can disappear if they cannot adapt. Human population require industry and houses, but in turn, the flora and fauna get trapped as threatened, endangered or extinct species.
2. **Pollution:** The pollutants of synthetic, toxic compounds, wastes and radioactive products can reduce the fate of environment.
3. **Introduction of Strong Species:** When exotic non-native, species are introduced into new **habitat**, the place of the original owners are threatened. **Lantana camara is the exotic species** which threatened survival of many native Indian species. **Nile Perah, exotic predatory fish**, which was introduced into **lake Victor in South Africa is causing problem for small Cichlid fish in the region**.
4. **Extinction:** The extinction phenomenon can be natural. History suggests that several species have suddenly disappeared. This happens without giving clue and it is due to catastrophic drastic changes. The anthropogenic extinction is man-made. This requires critical examination. The monitoring centre in the world has recorded that as many as 384 plant species are extinct.

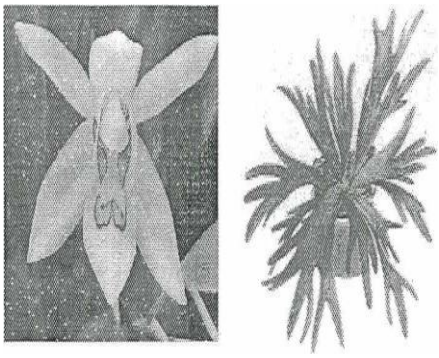
7.6 International Union for Conservation of Nature Red List

In 1963, International Union for Conservation of Nature and natural products has created a red list of species, which require urgent attention. Out of **18,000 green** listed, 1,100 are threatened species. There are various categories of species in the Red List. These are conventional approaches to the list, i.e., extinct in the wild's unit, critically endangered, vulnerable, low risk, etc.

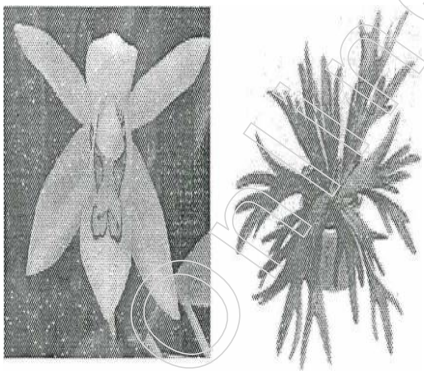
- **Position of Endangered Species:** The year 2000 list include 11,096 species containing 5,485 animals and 5,611 plants. These are endangered vulnerable (i.e., high risk of extinction). Out of 11,096 species, 1,949 are listed critically endangered. These 925 animals and 1,014 plants species listed critically endangered are at a high risk and require urgent attention.

Notes

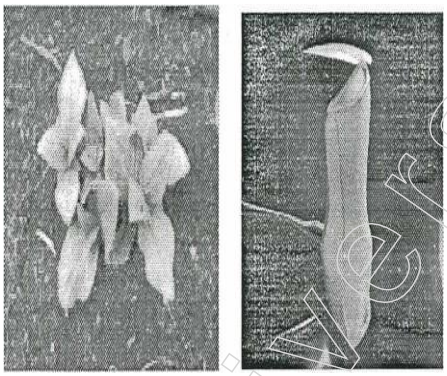
Some Endemic and Endangered Plants



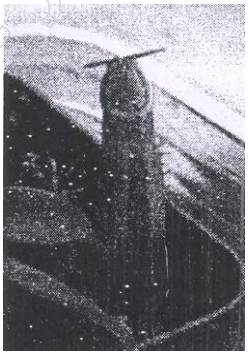
An endangered endemic orchid of Eastern Himalayas



Platycerium, rare and endemic to Manipur



Toothbrush orchid endemic to Sikkim

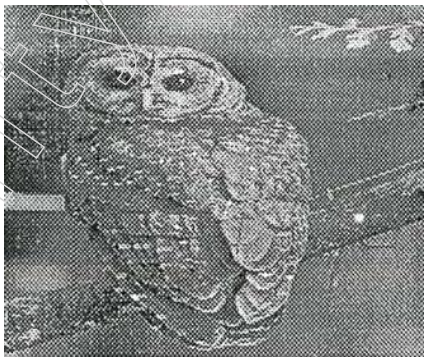


Nepenthes Khasiana (Pitcher plant), endangered and endemic

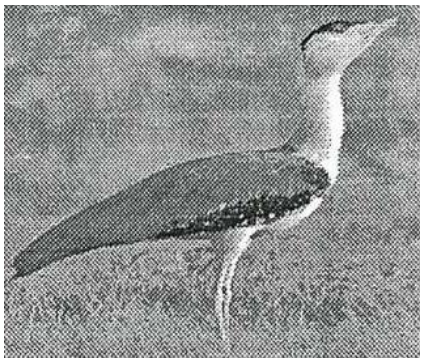
- **Threatened Species in India:** In India, nearly 450 plants are classified as rare 150 mammals and 110 species of birds are threatened or have become rare.

Existence of approximately 150 mammals and 150 kinds of birds are projected to be threatened, and also, an unidentified number of species of insects are vanishing too.

A few species of endangered reptiles, birds, mammals and plants are given below:



Spotted Owl



The Great Indian Bustard

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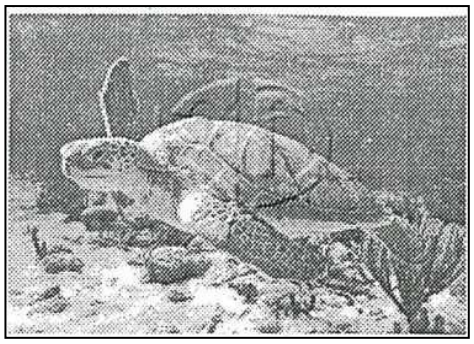

Tortoise

Table 7.5: Endangered Species

Reptiles	Gharial, Green Sea Turtle, Tortoise and Python.
Birds	Indian Bustard, Peacock, Pelican, Hornbill and Siberian White Crane.
Carnivorous Mammals	Indian Wolf, Red Fox, Bear, Red Panda, Tiger, Leopard, Stripped Hyena, Indian Lion, Golden Cat, Desert Cat and Dugong.
Primates	Hoolock Gibbon, Lion-tailed Macaque, Nilgiri Langur, Capped Monkey and Golden Monkey.
Plants	A large number of orchids, rhododendrons and medicine plants like Rauvolfia Serpentine, the Sandal wood tree Santalum, Cycas beddonei, etc.

According to a survey by Zoological Society of India, **Cheetah, Pink-headed Duck** and **Mountain Quail** have become extinct.

The reasons for these problems may be **from loss of habitat, poaching to man-wildlife conflicts.**

Extinct: It means these breeds of animals are not seen in the wild for about fifty years, e.g., Passenger pigeon, Dodo.

Endangered: It means that its number has reduced a critical level as habitats have been reduced such that if the immediate steps for protection and conservation are not taken, the species is in danger of extinction

Vulnerable: It means the population is declining continuously and systematically due to habitat destruction or overexploitation. The number is still over the critical mark, but has serious threat of becoming endangered.

Rare: It means risk is heavy as these are localized within specific areas, i.e., these are prevalent. These may be thinly scattered over a longer area.

Endemic: It means exclusively area-specific. India has two spots called Biodiversity hotspots Out of the 47,000 types of floras in our nation, 7,000 are endemic, 62% Indian pervasive flora is restricted to Himalayas, Khasi Hills and Western Ghats. These are Orchids, Sapria Himalayan, Uvaria Lurida, Nepenthes Khasiana, Pedicularis parroter, etc. Of 81,000 animals, a large number is endemic.

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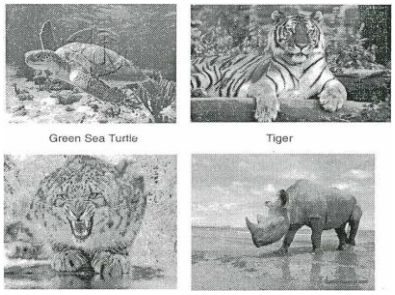
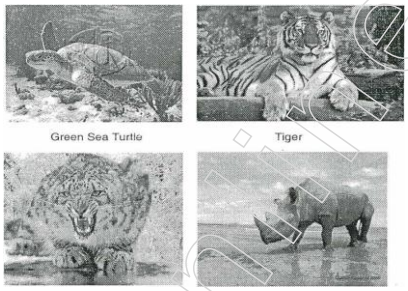
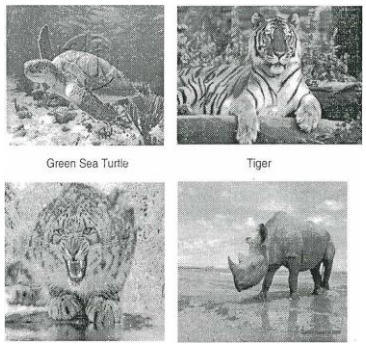


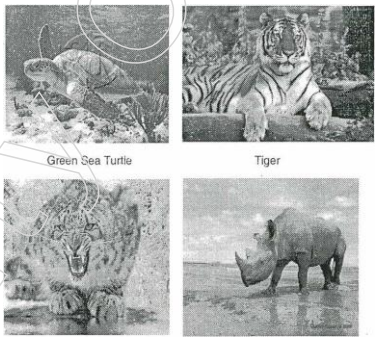
Green Sea Turtle



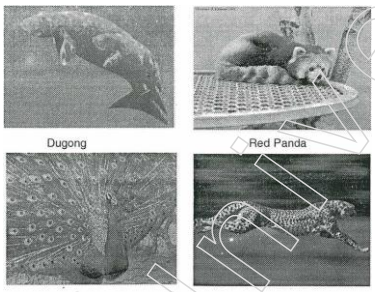
Tiger



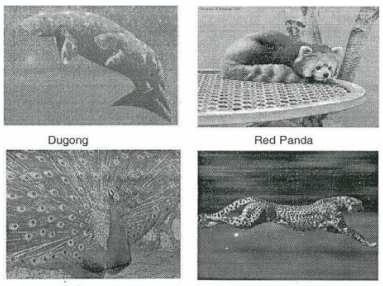
Snow Leopard



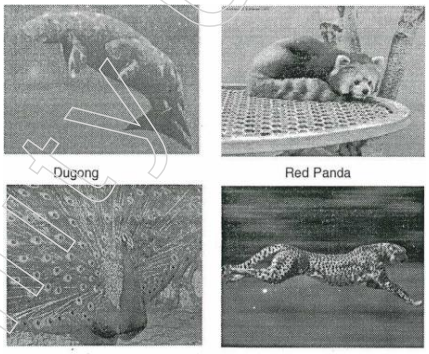
Black Rhinoceros



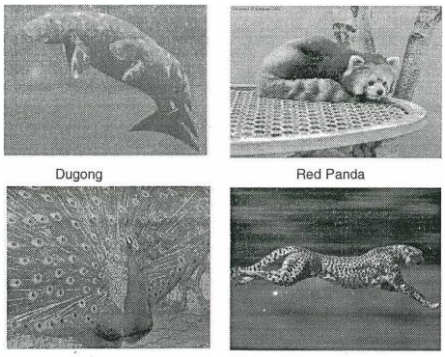
Dugong



Red Panda



Peacock



Cheetah

The remedial measures are projects such as conservation of tigers, elephants, etc., compensations to villagers, fencing, creating more fruits and crops near the limits for the species and there should be corridors for migration of wildlife.

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Notes

Value of Indian Biodiversity

India occupies a unique position among global biodiversity as a mega-biodiversity nation. A large number of species are native to India. It is stated among the top ten or fifteen nations of the world for its great, diversity of plant life, especially flowering plants, a source of new drugs being discovered during recent past. About 5000 species of flowering plants belonging to 141 genera and 47 families had birth in India. We are equally rich in insect, amphibia, reptiles, bird and mammalian species of great economic potential. Many of these are endemic to India, found nowhere else in the world. India is a source of traditional crop varieties ranking first amongst the 12 regions of diversity of crop plants and seventh so far in the contribution of agricultural species. India is the origin place of about 175 species of crop plants, and about 350 species of wild relatives of cultivated crops.

The wild relatives of different crop plants reported from India are as follows:

Table 7.6: Wild Relatives of Crop Plants

Crop	Number of Wild Relatives
Cereals and Millets	46
Pulses	81
Fruits	91
Spices and Condiments	28
Vegetables	76
Fibre Crops	15
Oilseeds	14

Out of the total number of flowering plant species known (ca 17,500) in India, there are more than 4,000 species used in medicines, about 3,000 for food, nearly 700 as traditional religious and social purposes, about 500 yield fibre, 400 as fodder, 300 yield gum and about 100 species are used to extract essential oils and scents. India has been primary centre for domestication of rice, sugarcane, banana, tea, mango, cucumber, citrus, cucurbits, beans, jute, cardamom, black pepper, ginger, turmeric, yam, taro, bamboo and jackfruit and secondary centre for domestication of potato, tomato, maize, sesame and soyabean.

India is rich in marine biodiversity among the coastline of 7500 km with exclusive economic zone of 202 million km^2, supporting the most productive ecosystems such as mangroves, coral reefs, estuaries, lagoons and backwaters. There are about 45 species of mangrove plants. Over 342 species of coral reefs belonging to 76 genera have been reported and about 50% of the global reef building corals are found in India.

Endemic species of both plants and animals are mostly found in North-East, Western Ghats, and Andaman and Nicobar Islands. In Western Ghats and North-East Himalayas, about 1500 and 2000 species of plants and animals respectively are endemic. About 33% of Indian endemic species belong to flowering plants.

Among animals, 135 genera have been reported as endemic, of which 85 (63%) are found in North-East India. Birds, representing about 14% of global avian fauna, show relatively high endemism. Among reptiles, 50% lizards are endemic, whereas 62% of amphibians are endemic, mostly in Western Ghats. Marine sediment worms, sponges and mayflies show high endemism.

Indian society has realized the value of its biodiversity since ancient times, conserving it as sacred groves, sacred seeds and sacred species. Biodiversity-rich

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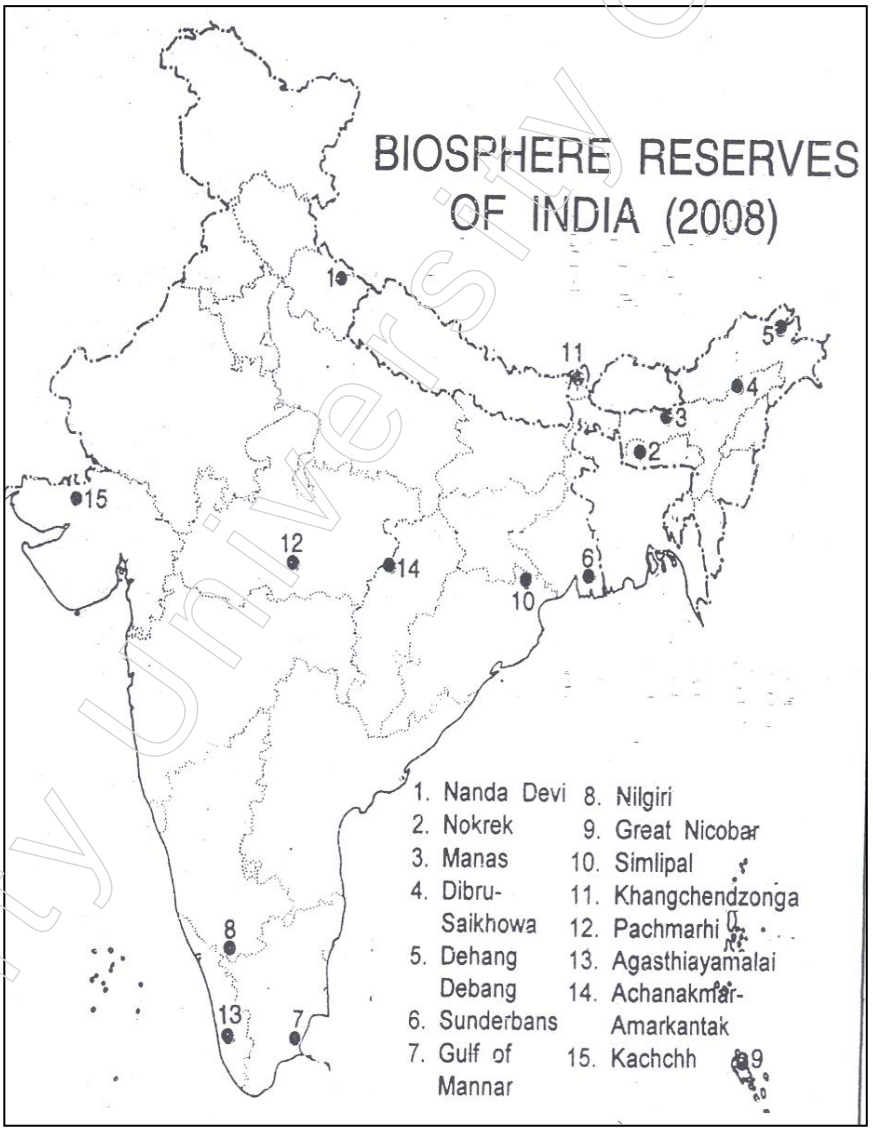
ecosystems are natural resources of our agriculture, livestock, forestry and fisheries. Indian biodiversity is a source of several life-saving drugs and novel chemicals. About 90% of all Indian medicines are obtained from plants. Many of the medicinal plants are being robbed by the pharmaceutical companies from the third world countries, including India. The major pharmaceutical companies of some developed countries such as American National Cancer Institute, Bristol-Meyers, Glaxo, Merck, Sharp and Dohne Research Lab, Monsasto/Searle, Shaman Pharmaceuticals and Smithkline Beecham are now actively involved in procuring information about traditional knowledge of such natural medicines. The flora and fauna including bacteria, algae, fungi, gymnosperms, flowering plants, protozoa, corals, sponges and anemones are being screened by such companies/institutions for natural products to develop drugs.



Map 7.2: Map Showing the Location of 15 Biosphere Reserves in India (MoEF, 2008)

(c) Amity University Online

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7.7 Hotspots of Indian Biodiversity

The Earth's Biodiversity is distributed in specific ecological regions. There are over a thousand major 'ecoregions' in the world. Out of these, 200 are recorded as most abundant, very rare and highly distinctive natural zones. These specific zones are denoted as the 'Global 200'.

It is so projected that 50,000 widespread floras, which include 20% of worldwide flora life-forms, perhaps are observed only in 18 'hotspots' in the world. Nations which comprise of a comparatively huge quantities of such biodiversity hotspots are stated as 'mega-diversity nations'.

Table 7.7: Global Species Diversity

Group	Number of Description Species
Bacteria and Blue-green Algae	4,760
Fungi	46,983
Algae	26,900
Bryophytes (Mosses and Liverworts)	17,000 (WCMC, 1988)
Gymnosperms (Conifers)	750 (Raven *et al*., 1986)
Angiosperms (Flowering Plants)	250,00 (Raven *et al*., 1986)
Protozoans	30,800
Sponges	5,000
Corals and Jellyfish	9,000
Roundworms and Earthworms	24,000
Crustaceans	38,000
Insects	751,000
Other Arthropods and Minor Invertebrates	132,461
Mollusks	50,000
Starfish	6,100
Fishes (Teleost)	19,056
Amphibians	4,184
Reptiles	6,300
Birds	9,198 (Clements, 1981)
Mammals	4,170 (Honacki *et al*., 1982)
Total: 1,435,662 Species	

Source: *Preserving the Biosphere's Organic Variety, WRI, IUCN, CI, WWF-US, the World Bank.*

Table 7.8: Global Hotspots of Biodiversity

	Hotspots	Plant Species	Endemic Plants	% of Global Plants	Vertebrate Species	Endemic Vertebrates	% of Global Vertebrates
1	Tropical Andes	45,000	20,000	6.7	3,389	1,567	5.7
2	Mesoamerican forests	24,000	5,000	1.7	2,859	1,159	4.2
3	Caribbean	12,000	7,000	2.3	1,518	779	2.9
4	Brazil's Atlantic Forest	20,000	8,000	2.7	1,961	567	2.1
5	Choc/Darien of Panama Western Ecuador	9,000	2,250	0.8	1,625	418	1.5

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6	Brazil's Cerrado	10,000	4,400	1.5	1,268	117	0.4
7	Central Chile	3,429	1,605	0.5	335	61	0.2
8	California Floristic Province	4,426	2,125	0.7	584	71	0.3
9	Madagascar	12,000	9,704	3.2	987	771	2.8
10	Eastern Arch and Seaside Forestry of Tanzania/Kenya	4,000	1,500	0.5	1,019	121	0.4
11	Western African Forests	9,000	2,250	0.8	1,320	270	1.0
12	Cape Floristic Province	8,200	5,682	1.9	562	53	0.2
13	Succulent Karoo	4,849	1,940	0.6	472	45	0.2
14	Mediterranean Basin	25,000	13,000	4.3	770	235	0.9
15	Caucasus	6,300	1,600	0.5	632	59	0.2
16	Sundaland	25,000	15,000	5.0	1,800	701	2.6
17	Wallacea	10,000	1,500	0.5	1,142	529	1.9
18	Philippines	7,620	5,832	1.9	1,093	518	1.9
19	Indo-Burma Eastern Himalayas	13,500		2.3	2,185	528	1.9
20	South-Central China	12,000	3,500	1.2	1,141	178	0.7
21	Western-Ghats Sri Lanka	4,780	2,180	0.7	1,073	355	1.3
22	South-Western Australia	5,469	4,331	1.4	456	100	0.4
23	New Caledonia	3,332	2,551	0.9	190	84	0.3
24	New Zealand	2,300	1,865	0.6	217	136	0.5
25	Polynesia/Micronesia	6,557	3,334	1.1	342	223	0.8
	Total	–	133,149	44.4	–	9645	35.3

*(***Source:** *Myers et al., 2000)*

Hotspots of Indian Biodiversity

N. Myers in 1988 introduced the term hotspots for the geographical regions particularly rich in endemic, rare and threatened species found in relatively small areas but facing significant threats to habitat loss. To qualify as a hotspot, the area must contain 0.5% (i.e., 1500) of the world's 3,00,000 plant species and should have lost 70% or more of its primary vegetation.

Biodiversity hotspots were originally identified by Norman Myers in 1990s. A hotspot (also written as hotspot) is an area which faces serious threat from human activities and supports a unique biodiversity with representatives of evolutionary processes of speciation and extinction. It is also defined as a geographical zone or ecological niche with a large number of endemic plants. Myers *et al.* (2000) identified 25 terrestrial hotspots of biodiversity all over the world, a habitat of about 133,149 endemic species of higher plants representing about 44% of the world's total vascular plant species. Out of 25 hotspots of the world, 15 are tropical rainforest regions such as Hawaii, Colombian Choco, West Ecuador, Uplands of West Amazonia, Atlantic forest area of Brazil, Eastern Madagascar, Peninsular Malaysia, East Himalayas, North Borneo Philippines, Queensland Australia and New Caledonia. The remaining hotspots such as California Floristic Province, Central Chile, Ivory Coast, Cape Floristic Province, East Arc forests of Tanzania, Western Ghats, Sri Lanka and Southwest Australia are in other climatic ecosystems. The number of hotspots in the world has now increased to 34 (just 1.4% of the world land, but supporting 60% of species of plants on the earth). Of

(c) Amity University Online

Notes

the 34 globally identified biodiversity hotspots, India harbors four hotspots. These are Eastern Himalaya, Indo-Burma, Western Ghats and Sri Lanka and Sundaland (Andaman & Nicobar Islands). The main attributes of these hotspots are given in Table 7.9.

The rate of deforestation in these areas is very high and ecosystems have reached at a fragile stage. The highest concentration of species is found in these areas. In addition to these, special hotspots are the mangroves, wetlands and swamps.

Table 7.9: Hotspots: Attributes

	Attributes	Eastern Himalaya	Indo-Myanmar	Western Ghats and Sri Lanka	Sundaland (Andaman & Nicobar Islands)
1.	Original area (km^2)	741,706	2,373,057	189,611	1,501,063
2.	Remaining vegetation area (km^2)	185,427	118.653	43,611	100.571
3.	Endemic plant species	3,160	7,000	3,049	15,0.00
4.	Endemic threatened birds	8	18	10	43
5.	Endemic threatened amphibians	4	35	87	59
6.	Endemic threatened mammals	4	25	14	60
7.	Extinct species	0	I	20	4
8.	Human population density (people/km^2)	123	134	261	153
9.	Protected area (km^2)	112,578	235,758	26,130	179,723

7.8 Conservation of Biodiversity

The immense worth of biodiversity because of their heritable, workable, medicinal, appealing, environmental and elective significance, highlights the necessity to preserve biodiversity. Gradually, we are coming to realize that wildlife is not just 'a game to be hunted', rather it is a 'gift of nature' to be nurtured and enjoyed. A number of measures are now being taken the world over to conserve biodiversity including plants and wildlife.

Following are the two to approaches preserve biodiversity:

(a) ***In-situ*** **Preservation (Inside Habitat):** This is accomplished by shielding wildlife plants and animals in the atmosphere itself, e.g., Environment Funds, National Parks, Sanctuaries, Reserve Forests, etc.

(b) ***Ex-situ*** **Preservation (External Habitats):** This is completed by formation of gene banks, seed banks, zoos, botanical parks, culture collections, etc.

In-situ Conservation

Currently, we have 7 main Environmental Funds, 80 National Parks, 420 Wildlife Sanctuaries and 120 Botanical Parks in our country covering 4% of the topographical extent.

The **Environmental Funds** preserve some representative ecologies as a whole for long-standing *in-situ* maintenance. In India, we have Nanda Devi (Uttarakhand), Nokrek (Meghalaya), Manas (Assam), Sundarbans (West Bengal), Gulf of Mannar (Tamil Nadu), Nilgiri (Karnataka, Kerala, Tamil Nadu), Great Nicobar and Similipal (Odisha)

Notes

Environmental Funds. Inside the Biosphere Reserves, we could have single or multiple national parks.

For example, Nilgiri Biosphere Reserve has two national parks, viz., Bandipur and Nagarhole National Park.

A **National Park** is a part devoted for the preservation of flora and fauna as well as its natural world. It is similarly intended for pleasure by the means of tourism but without causing zero damage to the ecosystem. Eating of local faunas, all private privileges and forestry actions are forbidden inside of a National Park. Each National Park typically has a sole purpose of preservation, precisely of some certain breeds of wildlife in addition to others. Some major national parks of our country are enlisted in the table below:

Table 7.10: Important National Parks of India

Name of National Park	State	Important Wildlife
Kaziranga	Assam	One-horned Rhino
Gir National Park	Gujarat	Indian Lion
Dachigam	Jammu & Kashmir	Hangul
Bandipur	Karnataka	Elephant
Periyar	Kerala	Elephant, Tiger
Kanha	Madhya Pradesh	Tiger
Corbett	Uttar Pradesh	Tiger
Dudwa	Uttar Pradesh	Tiger
Ranthambore	Rajasthan	Tiger
Sariska	Rajasthan	Tiger

Wildlife sanctuaries are also guarded zones where slaughter, shooting, firing or catching of flora and fauna is outlawed excluding under the regulator of uppermost authority. Nevertheless, private possession privileges are permitted and forestry procedures are too allowed to a level that they do not disturb the flora and fauna unfavorably.

Table 7.11: Some Major Wildlife Sanctuaries of Our Country

Name of Sanctuary	State	Major Wildlife
Ghana Bird Sanctuary	Rajasthan	300 breeds of birds (including migrant)
Hazaribagh Sanctuary	Bihar	Tiger and Leopard
Sultanpur Bird Sanctuary	Haryana	Migratory birds
Nal Sarovar Bird Sanctuary	Gujarat	Water birds
Abohar Wildlife Sanctuary	Punjab	Black buck
Mudamalai Wildlife Sanctuary	Tamil Nadu	Tiger, Elephant and Leopard
Vedanthangal Bird Sanctuary	Tamil Nadu	Water birds
Jaldapara Wildlife Sanctuary	West Bengal	Rhinoceros, Elephant and Tiger
Wild Ass Sanctuary	Gujarat	Wild Ass, Wolf, Nilgai and Chinkara

For floras, there is a solitary gene sanctuary for Citrus (Lemon family) and another reserve for Pitcher plant (an insect eating plant) in Northeast India. For the safety and maintenance of specific faunas, there have been explicit schemes in our nation, e.g.,

Project Tiger, Gir Lion Project, Crocodile Breeding Project, Project Elephant, Snow Leopard Project, etc.

Ex-situ Conservation

This kind of preservation is mostly done for protection of multiple crop plants, the wild relatives of crop plants and all the home-grown varieties with the foremost purpose of protecting the entire genetic variability of the crop breeds for forthcoming crop enhancement or afforestation programmes. In India, we have the following important **gene bank/seed bank** facilities:

1. **National Bureau of Plant Genetic Resources (NBPGR)** is situated in New Delhi. Here, farming and gardening crops and their wild relations are conserved by **cryo-preservation** of seeds, pollen, etc. by using liquid nitrogen at a temperature as low as –196°C. Various breeds of rice, pearl millet, Brassica, turnip, radish, tomato, onion, carrot, chilli, tobacco, poppy, etc. have been well-preserved effectively in liquid nitrogen for numerous years without damaging seed capability.
2. **National Bureau of Animal Genetic Resources (NBAGR)** located at Karnal, Haryana. It conserves the semen of domesticated bovine animals.
3. **National Facility Crop Plant Tissue Culture Repository (NFPTCR)** for the expansion of capability of maintenance of multiple of crop breeds by tissue culture. This service has been formed inside the NBPGR.

The G-15 nations are also determined to structure a system of gene banks to enable the maintenance of several diversities of fragrant and healing floras for which India is the networking coordinator country:

Table 7.12: Gene Bank Coordination

1995-1996	207
1996-1997	180
1997-1998	178
1998-1999	155
1999-2000	179
2000-2001	57 (till 31-12-2000)

Out of the 12 biodiversity "hotspots" in the world, India has one in the **North-East** and the further in the **Western Ghats.** Out of the 583 kinds of vascular floras particularly recognized as in **danger** either extinct or possible extinct while 287 are either weak or threatened and 237 are rare floras, likewise, of the 3 breeds of vertebrates, nearly two-third is non-existent, critical or scarce.

Biodiversity – Definitions (Addition)

1. Biotic variety defines the changeability amongst existing flora and fauna after entire foundations which includes *inter alia*, terrestrial, aquatic and other marine environments. It covers diversity within species amongst different kinds and of bionetworks.
2. It is **nothing but the life** on earth, or in the words, the natural **biological capital** of the earth.

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3. It is **the degree of variety in nature and not nature itself**. The environment comprises a lot extra than ten million of creatures. They vary broadly from each other. Such kind of dissimilarity of different life-forms is called Biodiversity.
4. It is the **richness** of **organisms**. It refers to entire quantity of breeds of microorganism, plants and animals living in biosphere or in a habitat or in an ecosystem.
5. Biodiversity entails **all forms of biological entities inhabiting the earth**.
6. It denotes **species richness**. **It is the sum of breeds of animals, plants and microorganisms that are present in their natural environment**.

Biodiversity Aspects and Mankind

(a) Biodiversity as an important valuable natural resource.
(b) Biodiversity as a valuable genetic resource.
(c) Biodiversity for maintaining healthy and stable ecosystem.
(d) Biodiversity in the ecosystem as effective weapon which ensures optimum utilization of abiotic resources.

Agro Biodiversity

It states the **biological diversity in agriculture**. **It is stroll evolutionary divergent area from biodiversity**. This branch has been recognized to differentiate between concern for **ecosystem** verses **agro-system**, wild forests flora and fauna versus agriculture related **plants, reptiles** and **insects**.

As per UNDP, 1985, (Traditional farming):

(a) Flora and fauna species are rich and large in number.
(b) There is a wide diversity of habitats in the local environment.
(c) Resources are radially available.
(d) It is very likely to have an enhancement in pest, weed and disease management.

Table 7.13: Widely Consumed Recent Medications Obtained from Different Floras

Drug	Plant Source	Use
Atropine	Belladonna	Anticholinergic; decreases abdominal discomfort in diarrhea
Bromelain	Pineapple	Controls muscle irritation because of infection
Caffeine	Tea and Coffee	Stimulant of the central nervous system
Camphor	Camphor tree	Rubefacient; upsurges local blood supply
Cocaine	Cocoa	Analgesic and local anesthetic; decreases discomfort and avoids aching during surgery
Codeine	Opium poppy	Analgesic; reduces pain
Morphine	Opium poppy	Analgesic; controls pain
Colchicine	Autumn crocus	Anticancer agent
Digitoxin	Common foxglove	Cardiac stimulant used in heart diseases
Diosgenin	Wild yams	Source of female contraceptive; prevents pregnancy

(c) Amity University Online

L-Dopa	Velvet bean	Controls Parkinson's Disease, which results in irregular actions of the hands
Ergotamine	Smut-of-rye or ergot	Control of hemorrhage and migraine headaches
Glaziovine	Ocotea glaziovii	Anti-depressant
Gossypol	Cotton	Male contraceptive
Menthol	Mint	Rubefacient; increases local blood supply and reduces pain on local application
Monocrotaline	Crotalaria sessiliflora	Anti-cancer agent
Papain	Papaya	Dissolves excess protein and mucus, during digestion
Penicillin	Penicillium fungi	General antibiotic, kills bacteria and controls infection by various microorganisms
Quinine	Yellow cinchona	Anti-malarial
Reserpine	Indian snakeroot	Reduces high blood pressure
Scopolamine	Thorn apple	Sedative
Taxol	Pacific yew	Anti-cancer (ovarian)
Vinblastine	Rosy periwinkle	Anti-cancer agent; controls cancer in children

(Source: **The Diversity of Life*, Edward O. Wilson,* Norton Paperback, in Association with Harvard University Press, 1993)**

7.9 Biological Diversity Act, 2002

An Act to provide for conversation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected therewith or incidental thereto.

Whereas India is rich in biological diversity and associated traditional and contemporary knowledge system relating thereto;

And whereas India is a party to the United Nations Convention on Biological Diversity signed at Rio de Janeiro on the 5th day of June, 1992;

And whereas the said Convention came into force on the 29th December, 1993;

And whereas the said Convention reaffirms the sovereign rights of the States over their biological resources;

And whereas the said Convention has the main objective of conservation of biological diversity, sustainable use of it components, and fair and equitable sharing of the benefits arising out of utilization of genetic resources;

And whereas it is considered necessary to provide for conservation, sustainable utilization and equitable sharing of the benefits arising out of utilization of genetic resources and also to give effect to the said Convention.

Be it enacted by Parliament in the Fifty-third Year of the Republic of India as follows:

Statement of Objects and Reasons.—Biodiversity encompasses the variety of all life on earth. India is one of the 12 mega-biodiversity countries of the world. With only 2.5% of the land area, India already accounts for 7-8% of the recorded species of the

Notes

world/India is equally rich in traditional and indigenous knowledge, both coded and informal.

2. India is a Party to the Convention on Biological Diversity (1992). The main objectives of the Convention are:
   (i) Conservation of biological diversity;
   (ii) Sustainable use of its components;
   (iii) Fair and equitable sharing of benefits arising out of utilization of genetic resources.
3. Recognizing the sovereign rights of States to use their own biological resources, the Convention expects the Parties to facilitate access to genetic resources by other Parties for environmentally sound purposes subject to national legislation and on mutually agreed upon terms (Articles 3 and 15). Article 8(j) of the Convention recognizes contributions of local and indigenous communities to the conservation and sustainable utilization of biological diversity through traditional knowledge, practices and innovations and provides for equitable sharing of benefits with such people arising from the utilization of their knowledge, practices and innovations.
4. Biodiversity is a multidisciplinary subject involving diverse sectoral activities and actions. The stakeholders is biological diversity include the Central Government, State Governments, institutions of local self-government, scientific and technical institutions, experts, non-governmental organizations, industry, etc. One of the major challenges before India lies in adopting an instrument which helps to realize the objectives of equitable sharing of benefits enshrined in the Convention on Biological Diversity.
5. After an extensive and intensive consultation process involving the stakeholders, the Central Government has decided to bring a legislation with the following salient features–
   (i) To regulate access to biological resources of the country with the purpose of securing equitable share in benefits arising out of the use of biological resources; and associated knowledge relating to biological resources;
   (ii) To conserve and sustainable use biological diversity;
   (iii) To respect and protect knowledge of local communities related to biodiversity;
   (iv) To secure sharing of benefits with local people as conservers of biological resources and holders of knowledge and information relating to the use of biological resources;
   (v) Conservation and development of areas important from the standpoint of biological diversity by declaring them as biological diversity heritage sites;
   (vi) Protection and rehabilitation of threatened species;
   (vii) Involvement of institutions of self-government in the broad scheme of the implementation of the Act through constitution of committees.
6. The proposed legislation primarily addresses the issue concerning access to genetic resources and associated knowledge by foreign individuals, institutions or companies, and equitable sharing of benefits arising out of the use of these resources and knowledge to the country and the people. In order to safeguard the interests of the local people, *vaids* and *hakims* and to allow

(c) Amity Directorate of Distance and Online Education

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research by Indian citizens within the country, the following exceptions are proposed:

(i) Free access to biological resources for use within India for any purpose other than commercial use for Indian people.

(ii) Use of biological resources by *vaids* and *hakims*.

(iii) Free access to the Indian citizens to use biological resources within the country for research purposes.

(iv) Collaborative research through government sponsored or government approved institutions subject to overall policy guidelines and approval of the Central Government.

7. It is proposed to have National Biodiversity Authority, State Biodiversity Boards and Biodiversity Management Committees.

(i) The National Biodiversity Authority will deal with matters relating to requests for access by foreign individuals, institutions or companies, and all matters relating to transfer of results of research to any foreigner; imposition of terms and conditions to secure equitable sharing of benefits and approval for seeking any form of Intellectual Property Rights (IPRs) in or outside India for an invention based on research or information pertaining to a biological resource obtained from India.

(b) State Biodiversity Boards will deal with matters relating to access by Indians for commercial purposes and restrict any activity which violates the objectives of conservation, sustainable use and equitable sharing of benefits.

(c) Biodiversity Management Committees will be set up by institutions of self-government in their respective areas for conservation, sustainable use, documentation of biodiversity and chronicling of knowledge relating to biodiversity. Biodiversity Management Committees shall be consulted by the National Biodiversity Authority and State Biodiversity Boards on matters related to use of biological resources and associated knowledge within their jurisdiction.

8. It is proposed to set up Biodiversity Funds at Central, State and local levels. The monetary benefits, fees, and royalties received as a result of approvals by National Biodiversity Authority will be deposited in National Biodiversity Fund. The Fund will be used for conservation and development of areas from where resources have been accessed.

9. Normally-traded commodities may be exempted by the Central Government, by notification, and in consultation with the National Biodiversity Authority, from the purview of the proposed legislation.

10. Traditional knowledge is proposed to be protected. It is also proposed that the State Governments notify National Heritage Sites, which are important from the standpoint of biodiversity, in consultation with institutions of local self-government.

11. The notes on clauses explain in detail the various provisions contained in the Bill.

Biological Diversity Act, 2002 Chapter – 1

Preliminary

Short Title, Extent and Commencement

Notes

1. This Act may be called The Biological Diversity Act, 2002.
2. It extends to the whole of India.
3. It shall come into force on such date as the Central Government may, by notification in the Official Gazette, appoint:

Provided that different dates may be appointed for different provisions of this Act and any reference in any such provision to the commencement of this Act shall be construed as a reference to the coming into force of that provision.

This clause gives the short title of the Bill, the area of its operation and the date of commencement of the Act and its various provisions.

Biodiversity Rules

Offences by Companies

This clause states that the provisions of the proposed legislation shall have overriding effect on all other laws for the time being in force or anything inconsistent with the proposed legislation contained in any instrument.

Offences to be Cognizable and Non-bailable

The offences under this Act shall be cognizable and non-bailable. This clause stipulates that the Central Government may give directions to the State Governments for execution any of the provisions of this Act *(Notes on Clauses).*

Act to Have Effect in Addition to other Acts

The provisions of this Act shall be in addition to, and not in derogation of, the provisions in any other law, for the time being in force, relating to forests or wildlife.

This clause provides that no Court shall take cognizance of any offence under this Act or rules/regulations made thereunder except for complaints made by National Biodiversity Authority or State Biodiversity Boards.

Power of Central Government to give directions to State Government

The Central Government may give directions to any State Government as to the carrying into execution in the State of any of the provisions of this Act or of any rule or regulation or order made thereunder.

This clause empowers the Central Government to make rules to carry out the provisions of the proposed legislation; enumerates the various matters in respect of which such rules may be made; and seeks to provide that every rule made shall be laid before Parliament *(Notes on Clauses).*

Cognizance of Offences

No Court shall take cognizance of any offence under this Act except on a complaint made by—

(a) the Central Government or any authority or officer authorized in this behalf by that Government; or

(b) any benefit claimer who has given notice of not less than thirty days in the prescribed manner, of such offence and of his intention to make a complaint, to the Central Government or the authority or officer authorized as aforesaid.

This clause empowers the State Governments to make rules to carry out the provisions of the proposed legislation; enumerates the various matters in respect of which such rules may be made; and seeks to provide that every rule made shall be laid before the State Legislature.

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Power of Central Government to Make Rules

1. The Central Government may, by notification in the Official Gazette, make rules for carrying out the purposes of this Act.
2. In particular, and without prejudice to the generality of the foregoing power, such rules may provide for all or any of the following matters, namely:
   (a) terms and conditions of service of the Chairperson and member under section 9;
   (b) powers and duties of the Chairperson under section 10;
   (c) procedure under sub-section (1) of section 12 in regard to transaction of business at meetings
   (d) form of application and payment of fees for undertaking certain activities under sub-section (1) of section 19;
   (e) the form and manner of making an application under sub-section (2) of section 19;
   (f) form of application and the manner for transfer of biological resource or knowledge under sub-section (2) of section 20;
   (g) form in which, and the time of each financial year at which, the annual report of the National Biodiversity Authority shall be prepared and the date before which its audited copy of accounts together with auditor's report thereon shall be furnished under section 28;
   (h) form in which the annual statement of account shall be prepared under sub-section (1) of section 29;
   (i) the time within which and the form in which, an appeal may be preferred, the procedure for disposing of an appeal and the procedure for adjudication, under section 50;
   (j) the additional matter in which the National Biodiversity Authority may exercise powers of the Civil Court under clause (h) of sub-section (6) of section 50;
   (k) the manner of giving notice under clause (b) of section 61;
   (l) any other matter which is to be, or may be, prescribed, or in respect of which provision is to be made, by rules.
3. Every rule made under this section and every regulation made under this Act shall be laid, as soon as may be after it is made, before each House of Parliament, while it is in session, for a total period of thirty days which may be comprised in one session or in two or more successive sessions, and if, before, the expiry of the session immediately following the session or the successive sessions aforesaid, both Houses agree in making any modification in the rule or regulation or both Houses agree that the rule or regulation should not be made, the rule or regulation shall thereafter have effect only in such modified form or be of no effect, as the case may be; so, however, that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule or regulation.

This clause empowers the National Biodiversity Authority to make regulations consistent with the provisions of the proposed legislation and the rules made thereunder. Such regulations are required to be made with the previous approval of the Central Government and by notification in the Official Gazette *(Notes on Clauses).*

Power of State Government to Make Rules

Notes

1. The State Government may, by notification in the Official Gazette, make rules for carrying out the purposes of this Act.
2. In particular, and without prejudice to the generality of the foregoing power, such rules may provide for all or any of the following matters, namely—
   (a) the other functions to be performed by the State Biodiversity Board under clause (c) of section 23;
   (b) the form in which the prior intimation shall be given under sub-section (1) of section 24;
   (c) the form in which, and the time of each financial year at which, the annual report shall be prepared under section 33;
   (d) the manner of maintaining and auditing the accounts of the State Biodiversity Board and the date before which its audited copy of the accounts together with auditor's report thereon shall be furnished under section 34;
   (e) management and conservation of national heritage sites under section 37;
   (f) the manner of management and custody of the Local Biodiversity Fund and the purposes for which such Fund shall be applied under sub-section (1) of section 44;
   (g) the form of annual report and the time at which such report shall be prepared during each financial year under section 45;
   (h) the manner of maintaining and auditing the accounts of the Local Biodiversity Fund and the date before which its audited copy of the accounts together with auditor's report thereon shall be furnished under section 46;
   (i) any other matter which is to be, or may be, specified.
3. Every rule made by the State Government under this section shall be laid, as soon as may be after it is made, before each House of the State Legislature where it consists of two Houses, or where such Legislature consists of one House, before that House.

This clause empowers the Central Government to remove difficulties which may arise in giving effect to the provisions of the proposed legislation by order published in the Official Gazette. Such order shall not be inconsistent with the provisions of the proposed legislation. This power can be exercised only within two years from the commencement of the proposed legislation. Every such order shall be required to be laid before Parliament *(Notes on Clauses)*.

Power to Make Regulations

The National Biodiversity Authority shall, with the previous approval of the Central Government, by notification in the Official Gazette, make regulations for carrying out the purposes of this Act.

Power to Remove Difficulties

1. If any difficulty arises in giving effect to the provisions of this Act, the Central Government may, by order, not inconsistent with the provisions of this Act, remove the difficulty:

   Provided that no such order shall be made after the expiry of a period of two years from the commencement of this Act.
2. Every order made under this section shall be laid, as soon as may be after it is made, before each House of Parliament.

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7.10 Summary

Biodiversity is a shortened form of 'biology' and 'diversity'. It refers to variations among groups of living organisms. Its resources include genetic resources, organisms and biotic components. As a resource, it must be utilized with caution because of its loss of 27 species every day. This loss is either man-made or genetically engineered. About one million species may disappear within next 20 years.

7.11 Check Your Progress

I. Multiple Choice Questions

1. Five hundred varieties of rice in India is an example of _____.
   (a) Genetic diversity
   (b) Ecosystem diversity
   (c) Diversity in the soil
   (d) Diversity in the amount of rainfall
2. In which part of India, one horned Rhino is found?
   (a) Western Ghats
   (b) Deccan Plateau
   (c) Kashmir
   (d) Assam
3. Out of the given options, which one of the following factors are mainly responsible for the loss of biodiversity?
   (a) Rainfall
   (b) Snowfall
   (c) Hillstone
   (d) Pollution
4. Out of the given options, which one of the following animals is on the edge of becoming non-existent because of unlawful shooting?
   (a) Rabbit
   (b) Deer
   (c) Gorilla
   (d) Bison
5. The variation of genes with the species is called _____.
   (a) Species diversity
   (b) Genetic diversity
   (c) Ecosystem diversity
   (d) None of these

7.12 Questions and Exercises

1. Write short notes on:
   (a) Genetic Biodiversity
   (b) Endemic Species
   (c) Threatened Animals
   (d) Hotspots of Biodiversity

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Notes

2. Explain ‘India is a mega diversity nation’.
3. What do you understand by ‘in-situ’ conservation?
4. Explain the societal worth of Biodiversity.

7.13 Key Terms

- **Biodiversity:** It denotes entire diversities of life forms originated on the earth.
- **Genes:** Elementary components of genetic data that are communicated through every generation.
- **Species:** Term used to specify a unit for like type of organisms.
- **Extinction:** Sudden disappearance of several species.
- **Fauna:** All animals present in a region.
- **Homeostasis:** An inherent property of living organisms or ecosystems to resist change and remain stable.

7.14 Check Your Progress: Answers

I. Multiple Choice Questions

Question	Answer
1	(a)
2	(d)
3	(d)
4	(c)
5	(b)

7.15 Further Reading and References

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