

ENVIRONMENTAL STUDIES

Harish C. Rai
Ritu Bir

Compliant to:

- ❖ New Education Policy
- ❖ Model Curriculum
- ❖ Outcome Based Education
- ❖ Bloom's Taxonomy

KHANNA PUBLISHERS®

Investing in Learning®

ENVIRONMENTAL STUDIES

DR. HARISH C. RAI

Ph.D., FIETE, MISTE

RITU BIR

Delhi College of Technology and Management.



KHANNA PUBLISHERS®

Operational Office : Investing in Learning®

4575/15, Onkar House, Opp. Happy School,
Ground Floor, Daryaganj, New Delhi 110 002

Phones : 011-45033819 • Mob. 09811541460

email : contactus@khannapublishers.in

Published by :

Romesh Chander Khanna & Vineet Khanna
for KHANNA PUBLISHERS
2-B, Nath Market, Nai Sarak
Delhi- 110 006 (India)

Website : www.khannapublishers.in

© 1979 and onward

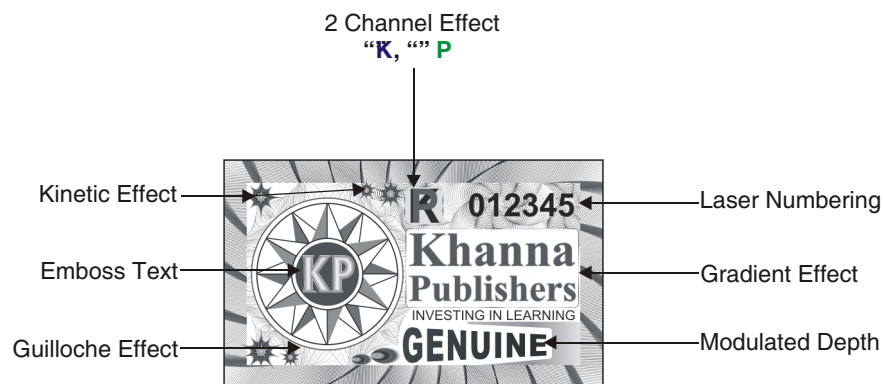
This book or part thereof cannot be translated or reproduced in any form without the written permission of the Authors and the Publishers. The right to translation, however, reserved with the author alone.

Copyright: Author and Publishers Jointly

Hologram & Description

To all readers of our books, to prevent yourself from being defrauded by piraters, please make sure that there is an Hologram on the cover of our books with the below specifications. If you find any book without Hologram and Description, please mail us at **contactus@khannapublishers.in**

Thanking you



ISBN No. : 978-81-952075-4-1

First Edition : 2021

Price : ₹ 189/-

PREFACE

If human society wants to live in harmony with nature, we need to learn a way of life that could be sustained by mother earth. Human society must learn to conserve natural resources, develop efficient technologies that minimizes the production of harmful wastes and control population size which is creating a huge burden on already diminishing resources. We must work together to produce and use renewable resources. A society based on these ideas is called as - Sustainable Society.

We must guide the human race living in a historic transitional period of burgeoning awareness of the conflict between human activities and environmental constraints to help and save the endangered planet with the already overtaxed natural resources. This present book 'Environmental Studies' provides the basic and pre requisite information regarding the various realms of environmental studies. Various case studies, illustrative figures and examples provide life to the subject and make one close to nature. This book has made an effort to explain all aspects of Environmental Studies- ecosystem, deforestation, biodiversity, wastewater treatment, renewable energy resources, disaster management, population explosion and many other such relevant concepts.

This book aims at providing basic knowledge in Environmental Sciences to engineering, management, law and humanities students. Since environmental science is even taught at school level, teachers may find this book quite informative.

I acknowledge the love and support of my loving kids Paarth and naman who have always encouraged me to work harder and extend heartfelt gratitude to my sisters and brother who are my pillars of strength.

We thank Khanna Publishers for their sustained efforts in bringing out this relevant book. We welcome all suggestions and constructive criticism of the book with a view to make it more informative.

—Authors

CONTENTS

Chapter	Pages
1. <i>Environmental studies A multidisciplinary subject.</i>	1—7
2. <i>Ecosystem</i>	8—31
3. <i>Natural Resources</i>	32—52
4. <i>Problems and Prospects</i>	53—88
5. <i>Problems and Prospects</i>	89—94
6. <i>Eco Friendly Polymers</i>	95—103
7. <i>Environmental Pollution</i>	104—131
8. <i>Disaster Management</i>	132—145
9. <i>Social Issues Human Population and the Environment</i>	146—164
<i>Experiments</i>	165—181
<i>Glossary</i>	182—187

Environmental studies

A multidisciplinary subject

Objectives

- Definition
- Components of environment
- Multidisciplinary nature of environmental studies
- Objective of environmental studies
- Scope and importance of environmental studies
- Need of public awareness
- Case study

MEANING AND DEFINITION

The term environment has been derived from a French word “Environia” means to surround. It refers to both abiotic (physical or non-living) and biotic (living) environment. The word environment means surroundings, in which organisms live. Environment and the organisms are two dynamic and complex component of nature. Environment regulates the life of the organisms including human beings. Ordinarily environment refers to the material and forces that surrounds the living organism.

1. According to P. Gisbert “Environment is anything immediately surrounding an object and exerting a direct influence on it.”

2. According to E. J. Ross “Environment is an external force which influences us.”

Thus environment refers to anything that is immediately surrounding an object and exerting a direct influence on it. Our environment refers to those things or agencies which though distinct from us, affect our life or activity. The environment in which man lives is surrounded and affected by factors which may be natural, artificial, social, biological and psychological.

COMPONENTS OF ENVIRONMENT

Environment mainly consists of atmosphere, hydrosphere, lithosphere and biosphere. Environment can be divided into:

(a) **Abiotic Components:** refers to all abiotic factors or non living components which affect living organisms and their functioning. Abiotic factors include parameters like temperature, light, rainfall, soil, minerals etc. It comprises of atmospheric conditions, water resources and land on which living organisms live.

(b) **Biotic Components:** refer to living organisms present in an ecosystem. Plants, animals and microorganisms are examples of biotic components living in environment.

MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES

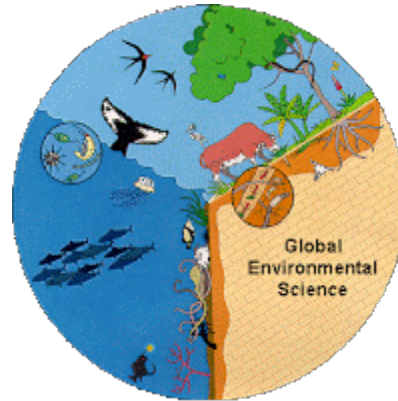


Fig. 1.1

The science of Environment studies is a multidisciplinary science because it depends on various disciplines like chemistry, physics, medical science, etc. It is the science of physical phenomena in the environment. It is inherently a multidisciplinary field that draws upon not only its core scientific areas, but also applies knowledge from other non-scientific studies such as economic, law and social science.

1. **Physics:**
 - To understand the flux of material and energy interaction.
 - To construct mathematical models of environment.
2. **Chemistry:**
 - To understand the molecular interactions in the system.
3. **Biology:**
 - To describe the effects within the plant and animal kingdom and their diversity.
4. **Atmospheric Science**
 - To examine the phenomenology of the Earth's gaseous outer layer with emphasis upon interrelation to other systems.
 - It comprises meteorological studies, greenhouse gas phenomena, airborne contaminants, sound propagation phenomena related to noise pollution, and even light pollution.
5. **Ecology:**
 - To analyze the dynamics among an interrelated set of populations, or a population and some aspects of its environment.
 - These studies could help study about endangered species, predator interactions, effect upon populations by environmental contaminants, or impact analysis of proposed land development upon species viability.
6. **Environmental Chemistry:**
 - To study the chemical alterations in the environment.
 - Principal areas of study include soil contamination and water pollution.
 - The topics of analysis involve chemical degradation in the environment, multi-phase transport of chemicals and chemical effects upon biota.

7. **Geo-science:**
 - It includes environmental geology, environmental soil science, volcanic phenomena and evolution of the earth's crust.
 - In some classification systems, it can also embrace hydrology including oceanography.
8. **Mathematics and Computer Science:**
 - It will help in environmental modeling and analysis of environment related data.
9. **Economics:**
 - It deals with economical aspects of various components of environment.
10. **Law:**
 - It helps in framing of environment related laws, Acts, rules and their monitoring.
11. **Social Science:**
 - It helps in dealing with population and health related issues.

OBJECTIVES OF ENVIRONMENTAL STUDIES

According to UNESCO (1971), the objectives of environmental studies are:

- (a) Creating the awareness about environmental problems among people.
- (b) Imparting basic knowledge about the environment and its allied problems.
- (c) Developing an attitude of concern for the environment.
- (d) Motivating public to participate in environment protection and environment improvement.
- (e) Acquiring skills to help the concerned individuals in identifying and solving environmental problems.
- (f) Striving to attain harmony with Nature.

According to UNESCO, the guiding principles of environmental education should be as follows:

- (a) Environmental education should be compulsory, right from the primary up to the post graduate stage.
- (b) Environmental education should have an interdisciplinary approach by including physical, chemical, biological as well as socio-cultural aspects of the environment. It should build a bridge between biology and technology.
- (c) Environmental education should take into account the historical perspective, the current and the potential historical issues.
- (d) Environmental education should emphasise the importance of sustainable development i.e., economic development without degrading the environment.
- (e) Environmental education should emphasise the necessity of seeking international cooperation in environmental planning.
- (f) Environmental education should lay more stress on practical activities and first hand experiences.

SCOPE AND IMPORTANCE OF ENVIRONMENTAL STUDIES

The disciplines included in environmental education are environmental sciences, environmental engineering and environmental management.

(a) **Environmental Science:** It deals with the scientific study of environmental system (air, water, soil and land), the inherent or induced changes on organisms and the environmental damages incurred as a result of human interaction with the environment.

(b) **Environmental Engineering:** It deals with the study of technical processes involved in the protection of environment from the potentially deleterious effects of human activity and improving the environmental quality for the health and well beings of humans.

(c) **Environmental Management:** It promotes due regard for physical, social and economic environment of the enterprise or projects. It encourages planned investment at the start of the production chain rather than forced investment in cleaning up at the end.

It generally covers the areas as environment and enterprise objectives, scope, and structure of the environment, interaction of nature, society and the enterprise, environment impact assessment, economics of pollution, prevention, environmental management standards etc.

The importance of environmental studies is as follows

1. To clarify modern environmental concept like how to conserve biodiversity.
2. To know the more sustainable way of living.
3. To use natural resources more efficiently.
4. To know the behaviour of organism under natural conditions.
5. To know the interrelationship between organisms in populations and communities.
6. To aware and educate people regarding environmental issues and problems at local, national and international levels.

NEED OF PUBLIC AWARENESS ABOUT ENVIRONMENT

It is not only the duty of government but also the people to take active role for protecting the environment, so protecting our environment is economically more viable than cleaning it up once, it is damaged.

The role of mass media such as newspapers, radio, television, etc is also very important to make people aware regarding environment. There are various institutions, which are playing positive role towards environment to make people aware regarding environment like BSI (Botanical Survey of India, 1890), ZSI (Zoological Survey of India, 1916), WII (Wild Life Institute of India, 1982) etc

Some of the reasons that we are facing various environmental challenges due to which people harm the environment are discussed below:

- **Growing Population** A population of over thousands of millions is growing. Over 17 million people are added each year. It puts considerable pressure on its natural resources and reduces the gains of development. Hence, the greatest challenge before us is to limit the population growth. Although population control does not automatically lead to development, yet the development leads to a decrease in population growth rates.

- **Poverty** India has often been described a rich land with poor people. Poverty and environmental degradation have a nexus between them. The vast majority of our people are directly dependent on the natural resources of the country for their basic needs of food, fuel, shelter and fodder.

- Environment degradation has adversely affected the poor who depend upon the resources of their immediate surroundings. Thus, the challenge of poverty and the challenge of environment degradation are two facets of the same challenge.

- Population growth is essentially a function of poverty. Because, to the very poor, every child is an earner and helper and global concerns have little relevance for him.

- **Agricultural Growth** People must be acquainted with the methods to sustain and increase agricultural growth without damaging the environment. High yielding varieties have cause soil salinity and damage to physical structure of soil.

- **Need for Ground water** It is essential to rationalize the use of groundwater. Factors like community wastes, industrial effluents and chemical fertilizers and pesticides have polluted our surface water and affected quality of the groundwater. It is essential to restore the water quality of our rivers and other water bodies as lakes. Deciding on suitable technologies for restoring the quality of groundwater aquifers is essential.

- **Development And Forests** Forests serve catchments for the rivers. The increasing demand of water, led to using rivers for irrigation projects. These caused forests to submerge and displacement of local people apart from damaging the local flora and fauna.

- Forests in India have been shrinking for several centuries owing to pressures of agriculture and other uses. Vast areas that were once green, stand today as wastelands. These areas are to be brought back under vegetative cover. The tribal communities inhabiting forests respects the trees and birds and animal that gives them sustenance. We must recognize the role of these people in restoring and conserving forests.

- The modern knowledge and skills of the forest department should be integrated with the traditional knowledge and experience of the local communities. The strategies for the joint management of forests should be evolved in a well planned way.

- **Degradation of land** A small portion of land possesses potential for production. Agricultural land suffers from varying degrees of soil degradation. Land degradation mainly occurs due to overgrazing and soil erosion due to wind and water.

- **Reduction of Genetic Diversity** Proper measures to conserve genetic diversity need to be taken. At present most wild genetic stocks have been disappearing from nature. Wild animals including the Asiatic Lion are facing problem of loss of genetic diversity. The protected areas network like sanctuaries, national parks, biosphere reserves are isolating populations. So, they are decreasing chances of one group breeding with another. Remedial steps are to be taken to check decreasing genetic diversity.

- **Evil Consequences of Urbanization** Nearly 27 per cent Indians live in urban areas. Urbanization and industrialization has given birth to a great number of environmental problems that need urgent attention. Over 30 percent of urban Indians live in slums. Out of India's 3,245 towns and cities, only 21 have partial or full sewerage and treatment facilities. Hence, coping with rapid urbanization is a major challenge.

- **Air and water Pollution:** Majority of our industrial plants are using outdated and population technologies and makeshift facilities devoid of any provision of treating their wastes. A great number of cities and industrial areas that have been identified as the worst in terms of air and water pollution. Acts are enforced in the country, but their implementation is not easy. The reason is their implementation needs great resources, technical expertise, political and social will.

Certain activities which help in creating awareness among public are

- People should join group to study nature such as WWF-I or BNHS or any other organization.
- Reading newspaper articles and periodicals like Down to earth, WWF-I newsletter, BNHS, Hornbill, Sanctuary magazine should be encouraged.
- Discuss environmental issues with friends and relatives.
- People should join local movements that support activities like saving trees in their locality, reducing use of plastics, going for nature treks, practicing 3 Rs i.e. reduce, reuse, & recycle.

- Practice and promote good civic sense and hygiene such as enforcing no spitting or tobacco chewing, no throwing garbage on the road and no urinating in public places.
- Take part in events organized on World Environment Day, Wildlife week etc.
- Visiting National parks, sanctuary or spending time in natural habitats should be encouraged.
- Celebrating event like World Environment Day : June 5th

Case Study

The Bishnois are considered as the first environmentalists of India. They are born nature lovers. They have, for centuries, married eco-conservation with their faith, making it one of the most ecologically relevant orders of today. Reverence for nature and all forms of life is what makes them a true 'BISHNOI'

Bishnoism is said to have started in 1485AD by Saint Guru Jambheshwar in the Thar Desert of Rajasthan. Long before the world came to know about the environmental crises, Bishnois have been cognizant of man's relationship with nature and the importance to maintain its delicate balance. It is remarkable that these issues were thought about, half a century ago by Bishnoi visionaries. .

Not many people know that the concept of Tree Huggers and Tree-Hugging, have roots in the Bishnoi history. The famous 'Chipko Movement' was inspired by a true story of a brave lady called Amrita Devi Bishnoi who refused to let the kingsmen cut the trees. Her head was severed, Seeing their mother lay down her life for the trees, her daughters clung to them. Their heads were severed too. Agitated by the happenings, the neighboring village folk clung to the trees, as the massacre continued. More than 300 people were killed for non-obedience and for trying to protect the trees. When the king came to know of this, he was ashamed of his mistake. He apologized to the Bishnoi community, ordered to stop felling the trees and hunting of wild animals in Bishnoi areas and punished those who transgressed his orders. This sacrifice not only inspired the "Chipko Andolan" by Sunder Lal Bahuguna but also the Government of India in the form of "Amrita Devi Bishnoi Smrithi Paryavaran Award" for contributing to environment conservation.

The Bishnois are one of the first organized proponents of eco-conservation, wildlife protection.

EXERCISES

Objective Questions

1. The study of interaction between living organisms and environment is called as:

(a) Ecosystem	(c) Ecology
(b) Physiology	(d) Anatomy
2. The objective of environmental education is:
 - (a) Raise consciousness about environment.
 - (b) To teach environment appropriate behavior.
 - (c) Create environmental ethic that creates awareness about ecological
 - (d) inter dependence of economic, social and political factors in human community and environment.
 - (e) All the above.

3. Environmental education should be imparted at:
(a) Primary school level (c) Secondary school level
(b) College level (d) All levels
4. Increasing industrialization is causing danger to man's life by:
(a) Polluting the environment (c) producing more goods
(b) Urban environment (d) Utilizing waste land
5. Biotic environment includes:
(a) Flora (c) Water
(b) Air (d) Soil
6. Chipko movement was started by:
(a) Sunder lal Bahuguna and Chandi Prasad Bhatt
(b) Sambaji
(c) Baba Aamte (d) Bishnoi community
7. June 5 is celebrated as:
(a) World environment day (c) World Water day
(b) World forest day (d) World Ocean day
8. The term ecosystem was coined by:
(a) Odum (c) Tansley
(b) Charles Elton (d) Haeckel

Short question answer

1. Define environment.
2. What are the components of environment?
3. When is world environment day celebrated?
4. Who initiated the concept of chipko andolan?
5. Suggest any two activities to increase public awareness towards nature.
6. What is the scope of environmental studies?
7. Give the importance of environmental studies.
8. Write a note on bishnoi community.
9. Explain any three factors which cause environmental degradation.
10. Who coined the term ecosystem?

Long question answer

1. Why are environmental studies considered as multidisciplinary subject?
2. What are the steps taken by our government for environmental protection?
3. Why is it important to create public awareness towards environment?
4. Write a note on abiotic components of ecosystem.
5. Name different biotic components of environment explaining their role in nature.

Answers (Objective Questions)

1. (a) 2. (e) 3. (d) 4. (a) 5. (a) 6. (a)
7. (a) 8. (c)

Ecosystem

Objectives

- Introduction
- Ecosystem components
- Ecosystem- Structure and function
- Food chains and Food web
- Ecological pyramids
- Energy Flow in an ecosystem
- Ecological Succession
- Major Ecosystems in the world

INTRODUCTION

An ecosystem, a term very often used in biology, is a community of plants and animals interacting with each other in a given area, and also with their non-living environments. The non-living environments include weather, earth, sun, soil, climate and atmosphere. The ecosystem relates to the way that all these different organisms live in close proximity to each other and how they interact with each other, thus an ecosystem can be defined as:

“An ecosystem is a community of living organisms in conjunction with the nonliving components of their environment interacting as a system. These biotic and a biotic components are regarded as linked together through nutrient cycles and energy flow. “Ecosystem” word was first used in 1935 in a publication by British ecologist Earnst Tansley.

Ecosystems can be huge, with many hundreds of different animals and plants all living in a delicate balance or they could be relatively small, in particularly harsh places in the world particularly the North and South Poles, where the ecosystems are relatively simple because there are only a few types of creatures that can withstand the freezing temperatures and harsh living conditions.

STRUCTURAL COMPONENTS OF ECOSYSTEM

An ecosystem includes both the biotic and abiotic components.

Biotic Components

The living components of an ecosystem are called the biotic components. Some of these factors include plants, animals, as well as fungi and bacteria. These biotic components can be further classified, based on the energy requirement source. Producers, consumers, and decomposers are the three broad categories of biotic components.

- **Producers** are the plants in the ecosystem, which can generate their own energy requirement through photosynthesis, in the presence of sunlight and chlorophyll. These organisms are called producers as they manufacture their own food from simple organic substances. They are often said to be “**autotrophs**” which comes from the Greek word “autos” which means self and “trophikos” which means nursing that refers to nutrition.

Some producers manufacture food without the aid of sunlight by just using chemical energy of simple inorganic substances. During chemosynthesis, bacteria living on the sea floor or within animals use energy stored in the chemical bonds of hydrogen sulfide and methane to make glucose from water and carbon dioxide (dissolved in sea water). Pure sulphur and sulphur compounds are produced as by products and the process is called “**chemosynthesis**” and the organism is known as chemosynthesis bacteria. Plants which are photosynthetic and chemosynthetic bacteria are autotrophic organisms that produce food in the ecosystem.

Producers are mainly of the first stage of food chain for they are the one to sustain and produce food for other living creatures or biotic factors.

Macro Consumers

Macro consumers are the organisms which are dependent for food on other organisms hence, macro consumers may be described as **heterotrophic**. The hetero means other because the term describe organisms which feed on others, macro consumers are grouped into three categories according to their food preferences;

- **Plants-eaters (herbivores):** These are consumers who eats plant leaves, flowers, stems, roots and etc. Some of the few examples of herbivores are cows, horses and goats. Plant-eaters are vegetarian animals so meaning they do not eat meat of other animals.

- **Flesh-eater (carnivores):** These are animals that eat meat of other animals and some examples of carnivorous animals are dog, snake and hawk. They don't eat plants but only eat meat of the animals. It comes from the Greek word “Carni” which means meat.

- **Variety-eaters(Omnivores):** These are consumers who actually eat either plants or animal meat. Some examples of omnivorous animals are rat, chicken and man that eat both plants and animals.

- **Decomposers** are the fungi and bacteria, which are the saprophytes. They feed on the decaying organic matter and convert this matter into water, carbon dioxide, minerals and other simple chemicals. The saprophytes play a vital role in recycling the nutrients so that the producers i.e. plants can use them once again.

Abiotic Factors

An abiotic factor is a non-living component in the environment. Abiotic factors fall into three basic categories: climatic, edaphic and social. Climatic factors include humidity, sunlight and factors involving the climate. Edaphic refers to soil conditions, so edaphic abiotic factors include soil and topography of the land. Social factors include how the land is being used and water resources in the area.

Certain Climatic Parameters which Affect Ecosystem are

Temperature and Light

Temperature of the air and water affect animals, plants and humans in ecosystems. A rise in temperature has the potential to change the way a living thing develops, because it changes the metabolic rate of the organism. All living organisms have a tolerance level for temperature range. For example, a human being would die if he stood out in minus 50 degree temperatures for any length of time. Light exposure often affects the temperature.

Water

All living organisms need water for survival. Water covers 70 percent of the earth's surface and falls as rain or snow over land. In an environment with little water, only organisms requiring a small percentage of water can survive. Other animals thrive in conditions with large amounts of water, such as marine animals and plants in oceans. Water is essential to survival, but every organism requires different amount of water for survival.

Atmosphere

The atmosphere of the earth sustains life. Animals and other creatures breathe oxygen or filter it from water. Plants prepare food because of the presence of carbon dioxide in it. Living things combine oxygen and carbon to make carbohydrates that provide energy and are important component of DNA, proteins and other organic materials.

Wind

The wind speed and direction affects the temperature and humidity of an area. Very high wind speeds, often in mountainous areas, may lead to stunted plant growth and limit the types of life that can thrive in the area. Wind also carries seeds and aids pollination, which allows plants to travel out of a contained area.

Inorganic Substances

Carbon, nitrogen, oxygen, calcium, phosphorus and their compounds constitute the abiotic inorganic elements.

Organic Substances

Carbohydrates, proteins, lipids, nucleic acids are some of the organic substances which are present in organisms which upon death are broken down by the action decomposers into inorganic substances for their recycling.

Function of Ecosystem

Major Functions of ecosystem are as follows:

- It regulates flow rates of biological energy.
- It regulates flow rates of nutrients.
- It helps in biological regulation including – Photoperiodism, nitrogen fixing organisms.

An ecosystem is a discrete structural, functional and life sustaining environmental system. The environmental system consists of biotic and abiotic components in a habitat. Biotic component of the ecosystem includes the living organisms; plants, animals and microbes whereas the abiotic component includes inorganic matter and energy.

Abiotic components provide the matrix for the synthesis of organic components (protoplasm). The synthesis involves energy exchange and this energy comes from the sun in the form of light or solar energy.

Thus, in any ecosystem we have the following functional components

- (i) Inorganic constituents (air, water and mineral salts)
- (ii) Organisms (plants, animals and microbes), and
- (iii) Energy input which enters from outside (the sun).

These three interact and form an environmental system. Inorganic constituents are synthesized into organic structures by the green plants (primary producers) through photosynthesis and the solar energy is utilized in the process. Green plants become the source of energy for herbivores

ENVIRONMENTAL STUDIES

About the Book:

This book is written in accordance with the latest syllabus framed by the University Grants Commission for the course 'Environmental Studies'. This book caters to all the undergraduates of engineering, management, science, law, humanities and students preparing for various competitive exams. This book has taken a holistic approach for easy understanding of the subject by including a number of case studies, illustrative figures and logical comprehension. This book has been divided into ten chapters including one unit which deals with practical study. Each chapter has been designed in such a way that students can grasp the concept with ease. Language of the book has been kept simple and at the end of each chapter multiple choice questions and review questions have been given for self assessment of students.

About the Authors:

Harish C. Rai, formerly Controller of Examination, Director Academic Affairs and Director Research Project Monitoring Cell, was the Advisor for All India Council of Technical Education, New Delhi, Controller of Examinations, Guru Gobind Singh Indraprastha University, Delhi, and Professor in the Department of Electrical and Electronics Engineering C.R. State College of Engineering, Murthal (Sonipat) Haryana. He obtained his graduate and postgraduate degrees from Delhi College of Engineering, Delhi and also completed Ph.D. (Electrical Engineering) from Indian Institute of Technology, New Delhi.

Dr. Rai was awarded Dr. S Radhakrishnan National Teacher's Award in 1997, Spardha Shree Award in 1999 for meritorious services in Education, and Teachers Excellence Award in 2000 for valuable services rendered to the cause of education in the country. Dr. Rai has an experience of about 37 years in administration including teaching undergraduate courses in the areas of electrical machines, control engineering, power electronics and power system, etc. He has presented several papers in International and National Conferences. His current interest areas include Electrical Machines and Control of Electrical Machines and Biomedical Electronics.

Ritu Bir did her postgraduation from Environmental Science in the year 2003 and had received an award for scoring above ninety percent. She also completed her M.Phil in Environmental Science. She has taught in various Engineering Colleges of repute like Manav Rachna Educational Institutes, Galgotias College of Engineering and Technology. At present she is working as a senior faculty in Delhi College of Technology and Management. She has authored two books for engineering students which have been written in accordance with UGC.



KHANNA PUBLISHERS®

ISO 9001:2015

4575/15, Onkar House, Opp. Happy School,
Ground Floor, Daryaganj, New Delhi-110002

Phones: 011-45033819, 9811541460

E-mail: contactus@khannapublishers.in



Website:
www.khannapublishers.in

ISBN 819520754-5



9 788195 207541