

Environmental STUDIES

FROM CRISIS TO CURE

THIRD EDITION

According to the latest UGC syllabus

R. Rajagopalan

Former Professor

Indian Institute of Technology Madras

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Features of

MAIN QUESTIONS ADDRESSED

- What is the scientific assessment of the causes and effects of global warming and climate change?
- Why have the greenhouse gas emissions been going up steadily?
- What are the international and Indian efforts to tackle the issue of climate change?
- How did ozone depletion occur and how was it controlled through an international agreement?
- What are the causes and effects of acid rain and what can be done about it?

KEYWORDS AND PHRASES

acid rain, carbon credit, carbon trading, chlorofluorocarbon (CFC), Clean Development Mechanism, climate change, global warming, greenhouse gas, Intergovernmental Panel on Climate Change (IPCC), Kyoto Protocol, Montreal Protocol, Ozone Depleting Substance (ODS), ozone layer, Tuvalu, UN Framework Convention on Climate Change (UNFCCC)

Questions Addressed

Each chapter begins with the main questions addressed, providing a quick overview of what is covered in the chapter. This is followed by the keywords and phrases.

Opening Case Study

The opening case study helps you to connect with the theory explained in the chapter.

THE STORY OF THE HIMALAYAS: CLIMATE CHANGE AND MELTING GLACIERS

'If there is a paradise on earth, it is here, it is here, it is here,' said the Moghul emperor Jehangir while visiting Kashmir in the early seventeenth century. The beauty of the Himalayas is timeless.

The majestic Himalayas are not merely a range of mountains. They are considered to be the cradle of Indian civilization and have exerted great influence over Indian thought, culture, and of course the environment. They are not just the 'abode of snow' (as the name implies), but are venerated as the kingdom of the Gods.

Spread over 2000 km across South Asia, the Hindu Kush Himalayan region includes all or parts of Afghanistan, Bangladesh, Bhutan, China, India, Nepal, and Pakistan. The mountain range is the source of many rivers that nourish the land, including the great Indus, Ganga, and Brahmaputra.



The glacier Gangotri in the Himalayas
Credit: IndiaPicture/Mahatta Multimedia Pvt. Ltd

The region contains 55,000 glaciers, 40% of the earth's fresh water, and is a critical source for irrigation,

BOX 1.5 CONNECTIONS: *Vultures, Cows, Wild Dogs, and Rabies*



The vulture is the world's most efficient scavenger, but it is also a slow breeder. It lays just one egg every year. Thus the breeding could not match the speed with which the vultures were dying.

Now comes the unexpected connection in the story: When the vulture population declined, wild dogs

BOX 1.2 STATE OF THE PLANET: *Regular Reports*

- The United Nations Environment Programme (UNEP) produces periodically a comprehensive global state of the environment report, called the Global Environment Outlook (GEO). There is also a special GEO for the youth (<http://www.unep.org/geo/>).

health of the planet (www.worldwildlife.org; see also Chapter 9, Box 9.1).

- The Centre for Science and Environment (CSE), New Delhi, a public interest research and advocacy organization, issues an Annual State of India's Envi-

BOX 1.1 STATE OF THE PLANET: *Doomsday Clock—3 Minutes to Midnight*

The world is just '3 minutes' away from a major catastrophe arising from climate change and nuclear weapons. The Doomsday Clock has been set to 11.57 p.m.

The Doomsday Clock was created in 1947 by the Board of the magazine *The Bulletin of the Atomic Scientists*. *The Bulletin* was founded in 1945 by scientists who created the atomic bomb. Shocked by the devastation caused by the Hiroshima bomb, the scientists wanted to raise awareness about the dangers of nuclear technology.

The Clock is a symbolic indicator that warns the public about how close the world is to a potentially

civilization-ending catastrophe. Each year, the magazine's Board analyses threats to humanity's survival to decide where the Doomsday Clock's hands should be set. The closer the Clock is to midnight, the closer we are to global calamity.

In 1947, the Clock was set to 11.53 p.m. Since then the Clock was moved forward and backward depending on the state of the nuclear threat. When the US and the erstwhile USSR conducted their first tests of the hydrogen bomb, the hands were moved to 11.58 p.m. In 1991, when the world's superpowers signed the Strategic Arms Reduction Treaty, the Clock was set to 11:43 p.m.

Case Studies

The stories and case studies help you to understand the practical aspects of the environmental issues discussed in the chapter.

the Book

REVIEW: A SUMMARY OF THE KEY POINTS

- Environmental indicators show that the world is facing a global crisis.
- Climate change is the defining issue of this century. It is the biggest threat we have ever faced.
- We are the cause of the crisis. We consume natural resources at an ever-increasing rate, without giving nature time to regenerate them.
- We also pollute the world so much that nature cannot absorb all of it.
- Our unsustainable way of living can only lead to a catastrophe.
- The environmental crisis is rooted in our attitude of domination and exploitation of nature, based on the Idea of Progress.
- Many phenomena like population and consumption have been growing exponentially over the past 200 years or so. This has never happened before.
- The concept of Ecological Footprint expresses the amount of land needed to sustain the lifestyle of an entity—a person, a city, a country, etc.
- Humanity's Ecological Footprint is already more than 1.5. That is, we now require 50% more than the earth's area to sustain our consumption of natural resources.

Review

The review at the end of each chapter draws together the main concepts discussed within the chapter. This will help you to reflect on the important ideas discussed in the chapter.

Glossary

All the important terms have been highlighted in bold within the chapters and explained at the end of the book. This will help you to retain all the new terms learnt in the chapter.

Glossary

Abiotic components or conditions The non-living components or conditions of an ecosystem such as the natural resources and the atmospheric conditions.

Abyssal zone The cold and dark zone at the bottom of the ocean.

Acid rain Rain, mist, or snow formed when atmospheric water droplets combine with a range of man-made chemical air pollutants.

Agent Orange A compound herbicide used by the US army in the Vietnam War to kill all vegetation.

Agroforestry A system of land use that combines growing crops along with trees.

Algal bloom A population explosion of some pigmented marine algae seen as an explosion of colour on the ocean—orange, red, or brown.

Biodiversity (Biological diversity) The numbers, variety, and variability of living organisms and ecosystems. It covers diversity within species, between species, as well as the variation among ecosystems. It is concerned also with their complex ecological interrelationships.

Biodynamic farming A type of organic farming that exploits bio- and solar rhythms. It is based on the ideas of Rudolf Steiner.

Biofertilizer Living micro-organisms, cultured and multiplied for use as fertilizer.

Biofuel Fuel oil from the seeds of certain trees; it can be mixed with diesel and used in engines.

Biogas Gas generated from human and animal waste.

EXERCISES

Objective-type questions

In each case below, choose the best answer out of the given set of choices:

1. Which of the following is **not** a biome?
(a) Tundra
(b) Tropical rain forest
(c) Earth
(d) Desert
2. Which of the following is **not** found in a tropical rain forest?
(a) Desert area
(b) Rich diversity of plants and animals
(c) Acidic soil
(d) Abundant rainfall
3. Which of the following statements is **not** true with regard to global forests?
(a) Forests are adversely affected by acid rain.
(b) Forests are submerged by reservoirs created

- (a) Deserts are affected by human activities.
- (b) Plants do not adapt to deserts.
- (c) Animals do not survive in deserts.
- (d) Days and nights are always hot in deserts.

Short-answer questions

1. How do desert organisms survive the heat and lack of water?
2. Why are tropical rain forests important to us?
3. What are the ecosystem services provided by mountains?

Long-answer questions

1. How do biomes vary based on the temperature and precipitation of the region?
2. Describe the human impact on the world's forests.
3. What lessons can we learn from the two cases described in this chapter: The Western Ghats and the Silent Valley?

Exercises

A series of Objective-type questions, Short- and Long-answer questions, Critical thinking exercises, and Activities highlight the major topics covered in the chapter. The questions enhance learning and can be used for review and classroom discussion.

Companion Online Resources



Visit india.oup.com/orcs/9780199459759 to access both teaching and learning solutions online.

Online Resources

The following resources are available to support the faculty and students using this text:

For Faculty

- PowerPoint Slides

For Students

- Additional stories, text, model question papers, references, websites, and films
- Environmental calendar, timeline, organizations, careers, and so on
- Environmental news and updates, major meetings and agreements, new reports and studies, etc.
- Multiple choice questions

Steps to register and access Online Resources

Resources for instructors and students are developed to complement each text book and varies from book to book.

Step 1: Getting Started <ul style="list-style-type: none">• Go to india.oup.com Step 2: Browse quickly by <ul style="list-style-type: none">• BASIC SEARCH<ul style="list-style-type: none">○ AUTHOR○ TITLE○ ISBN• ADVANCED SEARCH<ul style="list-style-type: none">○ KEYWORDS○ AUTHOR○ TITLE○ SUBTITLE○ PUBLICATION DATE Step 3: Select title <ul style="list-style-type: none">• Select Product• Select Online Resources Step 4: View Resources <ul style="list-style-type: none">• Click on "View all resources"	Step 5: Sign in with your Oxford ID <p>Sign in with your Oxford ID</p> <p>I am a returning user</p> <p>Please sign in</p> <p>Email Address</p> <p>Password</p> <p>Remember your password?</p> <p>Sign In</p> Step 6: If you do not have an Oxford ID, register with us <p>Personal Details</p> <p>Name</p> <p>Email Address</p> <p>Register for an Oxford ID</p> <p>User Name</p> <p>Password</p> <p>Must be at least 8 characters and should include at least one capital letter, lower-case letter and number</p> <p>Confirm Password</p> <p><input type="checkbox"/> Do you accept the terms and conditions?</p> <p>Continue</p>	Step 7: Fill in your details <ul style="list-style-type: none">• Fill the detailed registration form with correct particulars.• Fields marked with '*' in the form, are mandatory.• Update Step 8: Validation <ul style="list-style-type: none">• We shall revert to you within 48 hours after verifying the details provided by you. Once validated, please login using your username and the password and access the resources. Step 9: Confirmation <ul style="list-style-type: none">• You will receive a confirmation on your email ID. Step 10: Visit us again <ul style="list-style-type: none">• Go to india.oup.com• Sign in with Oxford ID
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Preface to the Third Edition

*The highest education is that
which does not merely give us information
but makes our life in harmony with existence.*

Rabindranath Tagore
(1861–1941)

Writer, Artist, Philosopher, and Nobel Laureate

To the Student

I welcome you to an exciting, and possibly life-changing, experience!

Turn back and look at the cover image. It shows a polar bear with its two cubs somewhere in the Arctic. They are waiting for the water to freeze so that they can head out onto the sea ice to hunt seals. In recent years, however, the ice forms late and melts early—and the polar bears are in deep trouble. The change in the Arctic weather pattern is due to global warming and the resultant climate change.

Why should we worry about the far-off Arctic, polar bears, or climate change? You will find answers to such questions in this book.

This is the third edition of the textbook for a course on Environmental Studies. This is more than a textbook, however. It is about your life and what is in store for you and the future generations. It is about the present and future of the earth. The text and the stories are meant to evoke surprise and shock, despair and hope, resolve and action. You will surely return to it even after the course. It may change forever your perspectives on life and nature!

This textbook covers the latest syllabus of the Ability Enhancement Compulsory Course on Environmental Studies, prescribed by the University Grants Commission (UGC) under the new Choice-based Credit System. It also includes additional topics included in the syllabi of some universities. The book is meant for undergraduates of any discipline and assumes no background in mathematics or science beyond the level of the tenth standard.

The compulsory course on Environmental Studies for all undergraduate students is the outcome of a landmark judgement given by the Supreme Court of India in 2003. Responding to a public interest petition and acknowledging the declining state of the environment, the Court directed the government to make environmental education compulsory at all levels of education in the country.

This book will also be useful for those taking the UPSC civil services examinations. It covers the ecology/environment topics in the syllabi for the preliminary and main examinations.

What are the Special Features of This Book?

This book has variety and something of interest to everyone. Even as you cover the syllabus, learn the concepts, and answer the questions, you will:

- learn about the major environmental problems, such as runaway growth, imperilled ecosystems, disappearing forests, endangered species, dwindling natural resources, escalating pollution, growing population, dangerous toxins, and more;
- find out what is being done about these problems;
- read a large number of true environment-related stories about crises, solutions, successes, failures, interconnections, and inspirational individuals;

- reflect on meaningful quotations, discuss deeper issues, watch films and documentaries, and read related novels; and
- discover how YOU can make a positive difference to the state of the environment by doing projects, joining groups, and taking action at a personal level.

The main text is in a question–answer format (sometimes called the Socratic method). This format promotes effective learning by making you an active learner. I have tried to anticipate the questions likely to arise in your mind. The question format also lends itself to the SQ3R method of effective study explained separately.

While the keywords and phrases are listed in the beginning of each chapter, the key ideas are highlighted on the side. Each chapter ends with a summary, exercises, deeper questions for reflection, activities you can carry out as an individual and in a group, and additional resources including books, websites, and documentaries. You will also find an extensive glossary of terms at the end.

What is New in This Edition?

Since I wrote the second edition in 2011, the global environment has become even more critical and climate change has become a serious issue all over the world. I believe that climate change will be the most serious environmental issue for India and the world in the coming years. Hence, I have made it the integrating theme of this edition. Every chapter begins with a short description of the connection between climate change and the topic in question.

What else is new in this edition?

- Several new topics have been added to cover the syllabi of universities, which have modified the UGC guidelines for this course.
- A number of new stories have been included. The stories deleted from the previous editions have been shifted to the OUP Online Resource Centre (See below).
- All the stories and the text have been updated to reflect current reports and studies.
- A new section ‘Enjoy and Educate Yourself’ lists feature films and fiction on the theme of the chapter.
- All the boxes have been categorized as Concept, State of the Planet, Envirofact, Inspiration, Hope, and so on.
- Answers to objective questions have been given at the end of the book.
- Model papers for universities and also for the UPSC civil services examinations have been added.

Online Resource Centre

You will find additional resources on the OUP Online Resource Centre (ORC). Access the site india.oup.com, search for the book title, and follow the instructions. The ORC includes the following resources:

For faculty

- PowerPoint slides

For students

- Additional stories, text, model question papers, references, websites, and films
- Environmental calendar, timeline, organizations, careers, and so on
- Environmental news and updates, major meetings and agreements, new reports and studies, etc.
- Multiple choice questions



Access also my website (www.rrajagopalan.in) to read my blogs on environment and other topics and to find information on forthcoming workshops conducted by me and by others.

Give me your feedback—point out errors, give suggestions for improvement, ask for additional material, or share stories of your activities. My email address is rrgopalan2005@gmail.com.

Acknowledgements

I wish to thank the reviewers, who provided a feedback on the second edition, and students who sent me email messages with positive comments and questions. Special thanks are due to Dr Amrit Sen of Visva-Bharati, Santiniketan, for giving me permission to reproduce his translation of the Tagore poem in Chapter 21.

I should also thank all the participants in my programmes (in particular, the alumni of the Auroville workshops) for encouraging me to keep going!

R. Rajagopalan

Praise for the Previous Editions

'I wish to heartily congratulate you on your efforts leading to publishing the book and assure you of the enthusiastic support from faculty and students of BITS, Pilani, Goa, for the cause of Environment.'

—Prof. M.K. Deshmukh, BITS Pilani, Goa Campus

'It is certainly one of the best books I have seen, presented in such an interesting and proactive manner.'

—Shobha Menon, Founder Trustee of Nizhal, a trust for tree conservation

'I have read your book "Crisis to Cure" and have found it amazingly interesting and use it almost like a Bible for my Environment classes. The live examples given by you make it more like a storybook.'

—Dr Rashmi Sanghi, LNMIIT Jaipur

'Thank you for writing From Crisis To Cure, Mr Gopalan—it's my Bible! I gift it to everyone I feel is sensitive about the subject and there are so many now.'

—Piyali Gupta, Teacher

Preface to the First Edition

To the Student

‘Oh, no! Not one more subject and one more book to be mugged up!’ As it is, the load is heavy enough with so many tough and boring things to study. How can I manage the new course? Why should I bother about the environment?’

This could well be your response when told about the new compulsory course on Environmental Studies. As you read this book, however, you will discover that this subject is different from many others: It is about you, and the future of your family, community, humanity, and this fragile planet.

About This Book

This book is meant for undergraduates of any discipline and it assumes no background in mathematics or science beyond the tenth standard. It is based on the new University Grants Commission (UGC) syllabus that came in the wake of the landmark judgement of the Supreme Court of India in 2003, to prescribe a course on the environment for colleges and to consider the feasibility of making it a compulsory subject at every level in college education.

A short extract of the Supreme Court judgement is given below:

... for more than a century there was a growing realisation that mankind had to live in tune with nature, if life was to be peaceful, happy, and satisfied. In the name of scientific development, man started distancing himself from nature and even developed an urge to conquer nature. Our ancestors had known that nature was not subduable and, therefore, had made it an obligation for man to surrender to nature and live in tune with it.

Even as you cover the entire UGC syllabus, learn the concepts, and try the short-answer and essay questions, you will:

- learn about the major environmental problems, such as runaway growth, imperilled ecosystems, disappearing forests, endangered species, dwindling natural resources, escalating pollution, growing population, dangerous toxins, green laws, etc.;
- find out what is being done about these problems;
- discover how YOU can make a difference to the state of the environment;
- savour reading over one hundred short environment-related stories about crises, solutions, successes, failures, interconnections, and inspirational individuals; and
- reflect on the prologues, quotations, poems, and deeper issues.

In addition, this book will aid you in:

- finding ideas and guidance for meaningful field work;
- surfing the Internet for more information on environmental issues which interest you;
- locating books and magazines on the subject;
- choosing a satisfying and rewarding career in environment-related areas; and
- joining an environmental organization or forming one.

To make things easier for you, there is a glossary of terms.

This is in fact more than a textbook. It is about your life and what is in store for you. It is about the present and future of the Earth. The text and the stories are meant to evoke surprise and shock, despair



and hope, resolve and action. You will surely return to it even after the course. It may in fact change your life!

A Note on the References

The material in this book has come from a variety of sources: books, textbooks, journal papers, magazine articles, news reports, documentary films, etc. You will find at the end of the book an extensive list of references. Most of the websites cited were accessed during August–December 2004.

Feedback is Welcome!

Many a topic covered in this book could fit in more than one chapter. In this matter, I have followed the UGC syllabus except for a few minor adjustments. The publishers and I will be delighted to receive feedback and suggestions from you on any aspect of the book such as:

- an evaluation of the content, style of presentation, production, other features, etc.;
- any errors, inconsistencies, wrong figures, unclear illustrations, difficult terms, etc.;
- topics to be included in the next edition;
- an update on the stories and any additional information you may come across;
- new stories of environmental degradation, conservation efforts, individual and group attempts, successes and failures;
- other websites, stories, poems, quotations, etc.; and
- your experiences in environmental conservation.

Your feedback will help us improve the book. All feedback can be sent to rrgopalan2005@gmail.com. Thank you.

On a Personal Note

The writing of this book absorbed me totally for about a year. I went through various moods—curious, interested, mildly hopeful, extremely depressed. The horror stories were many, the hopeful ones were few. At times I wanted to give up, weighed down by the thought of the coming apocalypse. But I pushed on thinking of the one student whom the book may influence and convert into an environmentalist. The book is really for that unknown student. I hope, of course, that there will be many more than one!

R. Rajagopalan

The SQ3R Method of Effective Study

How can you study this textbook effectively for learning and remembering the material?

How do you normally study a chapter of a textbook? Plunge straight into it and read passively and quickly from the first section to the last? This could be the worst possible strategy! You may spend hours reading in that fashion, but that will not help you much when you face the examination.

This textbook has been designed to help you follow a very effective and well-known technique of study called the SQ3R method. This technique makes you an active reader, so that you will understand and remember the material and also do well in the examination.

What is the key idea behind SQ3R?

There is a basic difference between *reading* and *studying*. Passive, start-to-finish reading may be adequate for a novel or a magazine. While studying a textbook prescribed for a course, however, your motive and goal are different. Here your motive is to achieve mastery over the subject and your goal is to learn and be able to recall the material when needed.

SQ3R recognizes the fact that, while studying a textbook, the most important things you must do often occur *before* and *after* reading, not actually during the reading act itself. SQ3R makes you an active reader of the textbook, enabling you to learn and remember the material.

What is the SQ3R method of study?

SQ3R is an acronym for a 5-step reading and study method developed by Francis Robinson (1906–1983), who was a professor of psychology at Ohio State University (OSU) in the US. During World War II, thousands of US army personnel had to be trained very quickly in skills relevant to the war. Based on his research as well as earlier studies on study skills, Professor Robinson came up with the SQ3R method to help the army personnel learn new skills in a short period of time. Later, Robinson's book *Effective Study*, which described the method, became popular with all students in universities and schools. Even today, many US universities recommend this method to their new students.

What are the 5 steps of SQ3R?

There are five related activities in the method—Survey, Question, Read, Recite, and Review:

Survey Before reading a chapter, make a quick survey of what the chapter contains. It is like looking at a map to plan your route before you begin a journey.

Question While you are surveying the chapter, make up questions that you would like the chapter to answer. This approach keeps your mind alert and concentrated.

Read Read each section of the chapter, looking for answers to your questions. Be an active reader as you search for the answers. Separate the key ideas from the supporting details and examples.

Recite After reading each section of the chapter, recall your questions and try to answer them. Do not move to the next section until you can recite the key ideas and answer the questions.



Review Immediately after finishing the chapter, go back and answer all the questions. Review again the next day and later.

How should you study a chapter in this book following the SQ3R method?

Step 1: Survey Before you begin reading the chapter text:

- Read the following:
 - Chapter title
 - Quotation: Try to see the connection between the quotation and the main topic of the chapter
 - The statement connecting climate change and the topic of the chapter
 - Main Questions Addressed
 - Keywords and Phrases
 - Title of the lead story
- Read the section headings (questions) and the titles of Boxes.
- Read carefully all the Key Ideas given in small boxes on the side.
- Look at the tables, figures, pictures, cartoons, and other visuals in the chapter to get an overall idea.
- Go through the following sections at the end of the chapter:
 - Review: A summary of the key points
 - Think critically: Deeper questions for reflection and discussion
- Read the questions given under Exercises.

Step 2: Question While you are surveying the chapter, formulate the questions you expect the chapter to answer:

- Write down the section headings
- Convert the Box titles into questions and write them down.
- Add some of the questions given under Exercises—the ones you find interesting.
- Add your own questions.

While you survey the chapter and write down the questions, try to recall what you already know about the topics. Check whether you can answer any of the questions even without reading the chapter.

Step 3: Read Now you are ready to read the text.

- Select the section of the chapter you want to read.
- Read the Key Ideas.
- Look for text material that supports each Key Idea.
- As you read, look for answers to the questions you have written down.

Step 4: Recite After reading each section

- Try to answer the questions from memory: recite orally or write down in your notebook.
- Check back if you cannot answer a question.
- Make up mnemonics, if you find anything difficult to remember. A mnemonic is a word, sentence, poem, etc. that helps you remember something.

When you are able to answer all the questions, move to the next section. Follow the steps Read and Recite for that section.



Step 5: Review After finishing all the sections of the chapter

- Review immediately:
 - Recite the Key Ideas and important points
 - Answer the questions and do the exercises from memory. Note that the questions have been graded according to the level of difficulty.
 - Look for connections between sections.
 - Go through the section ‘Learn More’ at the end of the chapter. Access the websites and go through the books and articles. Watch the films, if you can.
 - Look for connections to other chapters.
- Review again the next day and later by reciting the Key Ideas and answering the questions.

Is SQ3R the best method of studying textbooks for all students and all courses?

Students differ widely in their motivation levels, general work habits, previous education, language competence, and so on. In the same way, textbooks differ in the way of presentation, difficulty levels of concepts, simplicity of language, format of a chapter, and so on. Thus, one method of study cannot suit all students and all textbooks. You will have to explore and find the study skill that suits you and the subject.

Even if you are not comfortable with the actual steps of SQ3R, try to follow the principles of learning it is built upon: Getting the larger context first, examining the textbook’s overall organizational plan, setting specific goals and then pursuing them, and using immediate recall and verbal paraphrase as aids to learning and retention.

Try these key elements while studying this textbook and others. It is very likely that you will learn better, faster, and retain more!

Where can you find more information on SQ3R and other such study skills?

For more information on SQ3R and other study skills, access the OUP Online Resource Centre (ORC) or some of the following websites:

1. Virginia Polytechnic Institute and State University, US: www.ucc.vt.edu/academic_support_students/study_skills_information/sq3r_reading-study_system/index.html
2. University of Chicago, US: <https://counseling.uchicago.edu/page/sq3r-improve-reading-comprehension>
3. Dartmouth College, US: <http://www.dartmouth.edu/~acskills/success/reading.html>
4. Bethel University, US: <http://cas.bethel.edu/dept/aesc/resources>

Finally, do share your questions and experiences with me through email!

Syllabus Mapping

The following table is a guide to the coverage of the topics listed in the new UGC syllabus for the Ability Enhancement Compulsory Course on Environmental Studies under the Choice-based Credit System.

Syllabus Topic(s)	Chapter(s)
Unit 1 : Introduction to Environmental Studies (2 lectures)	
Multidisciplinary nature of environmental studies; Scope and importance	1
Concept of sustainability and sustainable development	1, 19
Unit 2 : Ecosystems (6 lectures)	
What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: Food chains, food webs, and ecological succession	2
Case studies of the following ecosystems: (a) Forest ecosystem, (b) Grassland ecosystem, (c) Desert ecosystem	3
Case studies of Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	4
Unit 3: Natural Resources: Renewable and Non-renewable Resources (8 lectures)	
Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state)	5
Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies	6
Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity, and tribal populations	7
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Levels of biological diversity: Genetic, species, and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hotspots; India as a mega-biodiversity nation; Endangered and endemic species of India; Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic, and informational value	9
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Environment laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and Control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act; Nature reserves, tribal populations, and rights	15
Human–wildlife conflicts in Indian context	9
International agreement: Montreal and Kyoto protocols	14
International agreement: Convention on Biological Diversity (CBD)	10
Unit 7 : Human Communities and the Environment (6 lectures)	
Human population growth: Impacts on environment, human health and welfare	16
Resettlement and rehabilitation of project affected persons; Case studies	19
Disaster management: Floods, earthquake, cyclones, and landslides	18
Environmental movement: Chipko	7
Environmental movement: Silent valley, Bishnois of Rajasthan	3
Environmental ethics: Role of Indian and other religions and cultures in environmental conservation	15
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Unit 8 : Field Work (Equal to 5 lectures)	
Visit to an area to document environmental assets: River/ forest/ flora/fauna, etc.; Visit to a local polluted site—Urban/Rural/Industrial/Agricultural; Study of common plants, insects, birds, and basic principles of identification. Study of simple ecosystems—pond, river, Delhi Ridge, etc.	20

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The Global Environmental Crisis and Sustainable Development

As we watch the sun go down, evening after evening, through the smog across the poisoned waters of our native Earth, we must ask ourselves seriously whether we really wish some future universal historian on another planet to say about us: 'With all their genius and with all their skill, they ran out of foresight and air and food and water and ideas.'

U. Thant, UN Secretary-General, addressing the UN General Assembly, New York, 1970

MAIN QUESTIONS ADDRESSED

- What is the scale of the global environmental crisis and what are its causes?
- What is sustainable development?
- What is the scope of Environmental Studies and why should you study the subject?

KEYWORDS AND PHRASES

Carrying Capacity, climate change, Doomsday Clock, ecology, Ecological Footprint, environment, Environmental Studies, exponential growth, global warming, Idea of Progress, sea level rise, sustainable development

THE STORY OF GHORAMARA: CLIMATE CHANGE AND VANISHING ISLANDS



The Sundarbans is the largest mangrove forest in the world
Credit: IndiaPicture/Mahatta Multimedia Pvt. Ltd

Ghoramara, a tiny island 150 km south of Kolkata in the Sundarbans Delta, will soon vanish under the sea. Between 1972 and 2010, Ghoramara lost at least half of its land to the sea. Two other islands in the region have already disappeared and more are likely to follow.

Every year at least two **cyclones** hit the Sundarbans islands. The storms have grown increasingly intense, though less frequent. This means more coastal flooding, erosion, and more saline water moving in on the islands.

Dr Sugata Hazra, an oceanographer with Jadavpur University, has been studying the area for many years.

He gives the following reasons for the erosion and sinking of the islands:

- The sea level is going up and this is caused by climate change.
- Coastal **mangroves** were cut down to make way for farming. The mangroves used to bind the **topsoil**, but now the soil is being washed away.
- The farmers also used to dig wells to get fresh water for irrigating their fields. But in time, the underground reservoirs emptied and then collapsed.

The rainfall has also shifted to post-monsoon period affecting food production. This change in the rainfall pattern is also very likely due to climate change.

The change in the climate, ingress of sea water, and the shrinking **habitats** are also affecting the local **species** like the Bengal tiger and the Cheetal deer.

Some mangrove species are also being threatened with extinction due to increased salinity as well as pollution from industrial effluents. Between 1989 and 2009, there was a 5% loss in forest cover.

There are about 100 islands over an area of 9000 sq km in the Sundarbans. The rising sea could drown many of the islands during the coming decades. About 1.35 million people are currently at high risk from sea level rise, storm surges, and coastal flooding. 2.4 million others face moderate risk.

Already about 10,000 people have become refugees in other islands, while some have moved to Kolkata. Over the next 15 years, 70,000 more could be displaced.

As Ghoramara shrinks in size, its people have been moving further inland or to the larger island of Sagar. What will they do when Sagar itself begins to disappear?

What does the Story of Vanishing Islands Indicate?

The islands of the Sundarbans are not unique in their predicament. All over the world, countries consisting of small low-lying islands such as Tuvalu, Kiribati, and the Solomon Islands are facing the effects of the rising sea. The Maldives and Bangladesh could also face severe erosion in the future.

Sea level rise and severe weather are just two examples of the impact of **climate change** (Chapter 14). Almost every aspect of our lives will be affected by this phenomenon.

Climate change is the defining issue of this century. It is the biggest threat humanity has ever faced. The way we respond to this threat will shape the lives of the current and succeeding generations. Hence, the underlying theme of this edition of the book is climate change. It is for you, the reader, to understand the seriousness of the environmental crisis and climate change and join the movement to create a safe and sustainable world.

Key Idea

Climate change is the biggest threat that humanity has ever faced.

Scientists and many analysts are clear that we do not have much time. If we do not act fast, doomsday will be on us soon (Box 1.1).

BOX 1.1 STATE OF THE PLANET: *Doomsday Clock—3 Minutes to Midnight*

The world is just '3 minutes' away from a major catastrophe arising from climate change and nuclear weapons. The **Doomsday Clock** has been set to 11.57 p.m.

The Doomsday Clock was created in 1947 by the Board of the magazine *The Bulletin of the Atomic Scientists*. *The Bulletin* was founded in 1945 by scientists who created the atomic bomb. Shocked by the devastation caused by the Hiroshima bomb, the scientists wanted to raise awareness about the dangers of nuclear technology.

The Clock is a symbolic indicator that warns the public about how close the world is to a potentially

civilization-ending catastrophe. Each year, the magazine's Board analyses threats to humanity's survival to decide where the Doomsday Clock's hands should be set. The closer the Clock is to midnight, the closer we are to global calamity.

In 1947, the Clock was set to 11.53 p.m. Since then the Clock was moved forward and backward depending on the state of the nuclear threat. When the US and the erstwhile USSR conducted their first tests of the hydrogen bomb, the hands were moved to 11.58 p.m. In 1991, when the world's superpowers signed the Strategic Arms Reduction Treaty, the Clock was set to 11:43 p.m.



Now, the Clock has become a universally recognized indicator of the world's vulnerability to catastrophe from climate change, nuclear weapons, and new technologies emerging in other domains.

In January 2015, the Board set the Doomsday Clock to 11.57 p.m. and said:

Unchecked climate change, global nuclear weapons modernizations, and outsized nuclear weapons arsenals

pose extraordinary and undeniable threats to the continued existence of humanity, and world leaders have failed to act with the speed or on the scale required to protect citizens from potential catastrophe. These failures of political leadership endanger every person on earth.

Is There Really a Global Environmental and Climate Crisis?

Here are some indicators of the current state of the planet, drawn from various reports. (The new terms that appear in this chapter are explained in subsequent chapters and also in the end-of-the-book Glossary.)

Global warming and climate change

- There are clear signs of **global warming** and the resultant climate change: Average global temperatures have been rising during the twentieth century and the first decade of the twenty-first century was the warmest on record. Worldwide, extreme weather including droughts, floods, and storms has become more common. Glaciers all over the world are melting.
- In India, eight out of ten warmest years occurred during the decade 2001–2010. In 2013, the very severe cyclone Phailin made landfall on the Odisha coast, affecting 12 million people. Weather patterns have changed drastically in many parts of the country.

Population

- The world **population** reached 7 billion in 2011 and is expected to reach 10 billion by 2100. It took just 12 years for the population to increase from 6 to 7 billion. The largest share of population growth is expected in countries that are currently low-income ones.
- India's population was about 1.3 billion in early 2015. By 2050, with a projected population of 1.65 billion, we will be the most populous country in the world.

Water and sanitation

- Two billion people live in countries that are already water-stressed and, by 2025, two-thirds of the world population may suffer water stress. Some 80 countries suffer from serious water shortages now. Half the world population lacks sanitation facilities.
- During 1911–2014, India lost 50% of its lakes and **wetlands** to other uses. More than 60,000 villages are without a single source of drinking water. Over 110 million rural households are without toilets.

Biological diversity

- Worldwide, of the known species, 30% of amphibians, 25% of mammals, 12% of birds, 25% of reptiles, and 21% of fish species are threatened with extinction. The current extinction rate is estimated to be 100 to 1000 times the rate at which species naturally disappear.

- More than 10% of India's recorded wild **flora** and **fauna** are threatened and many are on the verge of extinction.

Forests

- During the decade 2000–2010, the world lost around 13 million ha of forest every year. Tropical forests are being cleared at the rate of 70,000 to 170,000 sq km annually (equal to 20–50 soccer fields per minute).
- India has lost about 94 million ha of natural forests since 2000.



A farmer ploughing his field

Credit: IndiaPicture/Mahatta Multimedia Pvt. Ltd

has the highest rate of deaths caused by chronic respiratory diseases in the world, primarily caused by such pollution.

Land

- Each year, 6 million ha of agricultural land are lost due to desertification and soil degradation. This loss affects about 250 million people in the world.
- About 40% of India's land has been degraded. We lose 5.3 billion tonnes of topsoil every year. During 2007–2014, 57,000 ha of land were diverted for industrial and non-agricultural uses.

Pollution

- At least 1 billion people in the world breathe unhealthy air and 3 million die annually due to air pollution. Air pollution levels are still above the World Health Organization (WHO) guidelines in most developing countries.
- WHO said in 2014 that Indian cities were among those with the highest levels of air pollution. India

Ocean and coastal areas

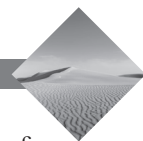
- Overfishing and ocean acidification is placing all of marine life at risk. Large areas of the ocean have become dead zones without any life. Worldwide, 50% of coastal mangroves and corals that perform vital ecological functions have been destroyed.
- Industrial effluents, domestic waste, agricultural runoff, shipping activity, and offshore exploration cause heavy pollution of the Arabian Sea and the Bay of Bengal. Over the past 40 years, India too has lost more than 50% of its mangrove forests.

Energy

- More than 2 billion people in the world go without adequate energy supplies. Even by 2030, nearly 3 billion people, mostly in rural areas in Africa and Asia, will continue to rely on fuelwood for cooking and heating, while about 1 billion people will have no access to electricity.
- India imports more than 80% of its oil needs, primarily to feed the transportation sector.

Urbanization

- More than half the world's population now lives in urban areas, compared to little more than one-third in 1972. About one-quarter of the urban population lives below the poverty line.



- About 23% of the population in India's million-plus cities live in slums. Just 33% of urban households have access to piped sewage system.

Environmental governance

- International negotiations over several years have not led to any agreement on limiting **greenhouse gas** emissions and tackling climate change.
- While India has many environmental laws and regulations, the implementation has always been lax. In addition, the rules are often seen as impediments to rapid economic growth and the government is always under pressure to relax them.

You can find many more such examples in regular and special reports on the state of the world's **environment** (Boxes 1.2 and 1.3).

BOX 1.2 STATE OF THE PLANET: Regular Reports

- The United Nations Environment Programme (UNEP) produces periodically a comprehensive global state of the environment report, called the Global Environment Outlook (GEO). There is also a special GEO for the youth (<http://www.unep.org/geo/>).
- The Worldwatch Institute, an independent research organization in the US, publishes an annual State of the World report that lists the significant events of the previous year and covers current environmental topics (www.worldwatch.org).
- WWF International brings out every other year the Living Planet Report, a science-based analysis of the health of the planet (www.worldwildlife.org; see also Chapter 9, Box 9.1).
- The Centre for Science and Environment (CSE), New Delhi, a public interest research and advocacy organization, issues an Annual State of India's Environment Report (www.cseindia.org).
- The International Union for Conservation of Nature (IUCN) publishes a Red List of **threatened species** of the world (www.iucn.org; see also Chapter 9, Box 9.2).

BOX 1.3 STATE OF THE PLANET: Examples of Thematic and Special Reports

- UN World Water Development Report, published every three years so far and annually from 2015 (www.unwater.org; see also Chapter 5, Box 5.1).
- Periodical Assessment Reports from the UN Intergovernmental Panel for Climate Change (IPCC). The Fifth Report was released in 2014 (www.ipcc.ch; see also Chapter 14).
- UN Millennium **Ecosystem** Assessment Report of 2005 (www.millenniumassessment.org; see also Chapter 2, Box 2.2).
- Report of the World Commission on Dams, published in 2000 (www.unep.org/dams/WCD/).

The picture is clear: Severe **environmental degradation** is happening all over the world. What is the reason for this depressing state of affairs? Scientists and **environmentalists** are clear that human activities have led to this crisis.

Should We Not Worry More about Problems such as Poverty, Armed Conflicts, and Terrorism than about the Environment?

It is true that the world is facing many serious issues such as:

- Wars, local conflicts, and terrorism
- Exploding population
- Agricultural crisis
- Widespread hunger, poverty, and extreme inequalities

Key Idea

1. We are consuming natural resources at a rate much higher than that at which nature can regenerate them.
2. As we consume the resources, we are also creating waste and pollution much faster than the rate at which nature can absorb them.

This is an unsustainable way of living and it can only lead to an environmental and social catastrophe.

- Massive **displacement** of people due to environmental changes and development projects
- Emergence of new diseases
- Corruption in politics and government
- Economic downturn and financial crises

However, all such issues and the environmental crisis are interrelated. Here are some examples of such connections:

- Conflicts of any kind degrade the environment through the planting of landmines, destruction of irrigation systems and water resources, interference in planting, harvesting crops, etc. There is also the real danger of future wars being fought over scarce resources like oil and water.
- Rapid increase in population puts enormous pressure on natural resources such as water, land, and biological diversity.
- Environmental degradation leads to droughts, crop failures, and rural poverty. It also forces people to migrate to cities looking for livelihood. This in turn creates unsustainable urban demand for water, power, sanitation, and so on.
- **Toxic waste** from cities and industries give rise to new diseases.
- Corruption enables the violation of environmental laws and regulations, leading to greater degradation.

Surely nature will take care of the environmental problems over time?

The earth has existed for 5 billion years, humanity for 3 to 5 million years, and civilization for 10,000 years. The earth and all its living beings have survived many crises and cataclysmic events. Looking back over centuries, nature seems to have absorbed disturbances and stayed always in balance. Thousands of species have survived over a long period and, consequently, could be expected to continue to exist forever. Will we not survive the current environmental crisis too?

The earth will surely survive this crisis and many species may survive too, but we may be wrong in assuming that humanity will also continue to exist forever. The reason is that there is something different happening now.

In the past, changes in nature were always slow but that is no longer true. Human activities have drastically increased the pace at which things change. What is happening now can be described by a simple mathematical curve or graph—the **exponential growth** of a quantity with time. This curve is relatively flat in the beginning, but becomes steeper and steeper with time (Read Box 1.4 for an explanation of exponential growth.)

BOX 1.4 **CONCEPT:** *Exponential Growth*

Suppose you invest ₹1000 in a bank, which gives you an annual interest of 10%. You ask the bank to reinvest the interest earned every year. (We call this compound interest.) At the end of the first year, your account will have grown to ₹1100. At the end of the second year,

the balance will be ₹1210 (₹1100 + 110). Thus, every year, an increased amount of interest gets added to the principal. What will be the accumulated amount at the end of 50 years? Guess the amount before reading further!



In 50 years, the amount would have grown to more than ₹117,000! If you did not know the power of compound interest, you would have surely underestimated the value. This kind of increase is called exponential growth.

Compare this growth with the case of simple interest. The initial deposit of ₹1000 will earn a constant amount of interest (₹100) every year. At the end of 50 years, the total amount will be only ₹ 6000 (original deposit of ₹1000 + interest of ₹5000). You can see for yourself how compound interest makes so much difference. This is the power of exponential growth.

Mathematically, any growth is exponential if the increase is at a constant rate per time period, rather than a constant amount. If you show exponential growth as a graph, the shape of the curve will be like the letter J. Figure 1.1 shows the growth of your investment of ₹1000 at a compound interest rate of 10%. You can also compare the growth with a simple interest of same value.

Many natural phenomena exhibit exponential growth. For example, the population of the world has been increasing exponentially. With every case of exponential growth we associate 'a doubling time'. This is roughly the time it takes for the quantity to double

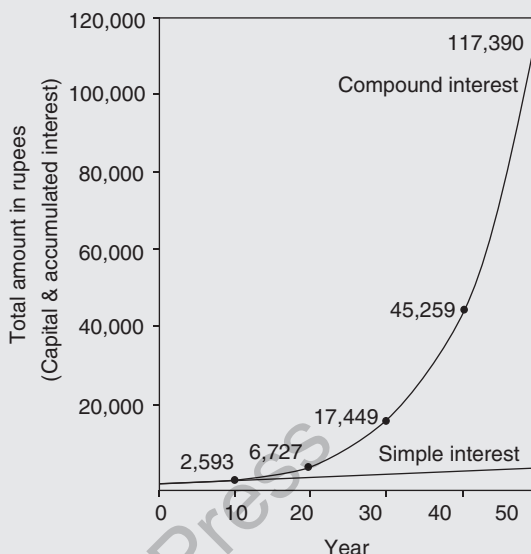


FIGURE 1.1 Curve Showing Exponential Growth

in value. You can get the doubling time by dividing the number 70 by the growth rate of the quantity. This formula is derived from the basic mathematics of exponential growth. World population doubles every 45 years or so.

Four such mega phenomena or spikes have been occurring, with profound implications for life on earth. These are the four quantities that are growing exponentially:

- Size of the human population (Fig. 1.2)
- Production and consumption of goods and services (Fig. 1.3)
- Concentration of carbon dioxide gas in the atmosphere (Fig. 1.4)
- Number of biological species becoming extinct every year (Fig. 1.5)

A remarkable fact is that, in each case, the curve was flat over centuries until the spike began in recent times. What makes matters worse is that the four spikes are interconnected, each amplifying the others. Let us take a closer look at these four phenomena.

Are There Too Many People on Earth?

The exponential growth in human population began in 1650 and now, every three days, the size increases as much as it did in a whole century before. We have to provide the current 7.3 billion people (and billions more to come) with food, water, shelter, education, medical facilities, and so on. This task looks even more formidable in the light of the impact of the other three spikes. Chapter 16 deals with the topic of population growth.

Are We Consuming Too Much?

The amount of natural resources used up every year began spiking around 1900 and the steady economic growth has led to extraordinary levels of unsustainable consumption. In the mad

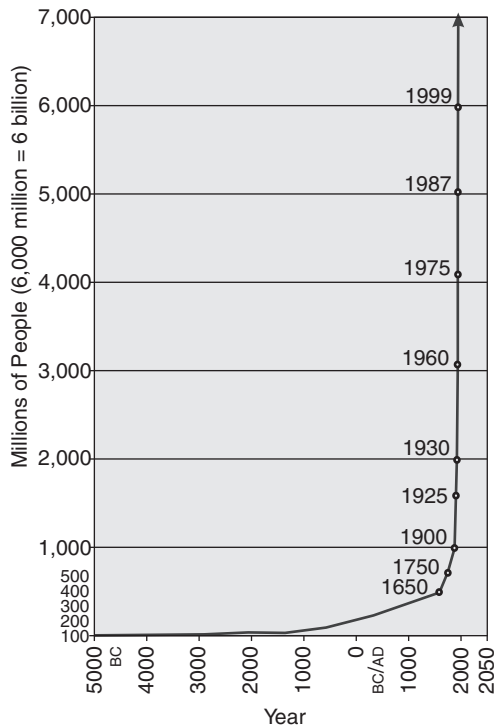


FIGURE 1.2 Growth of Population

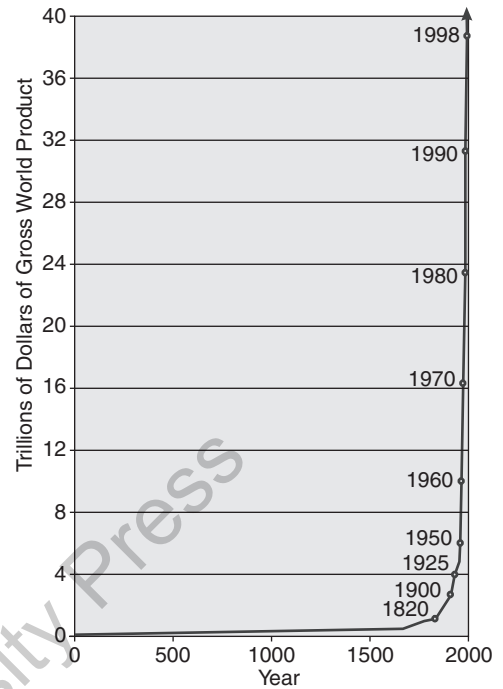


FIGURE 1.3 Growth of Consumption

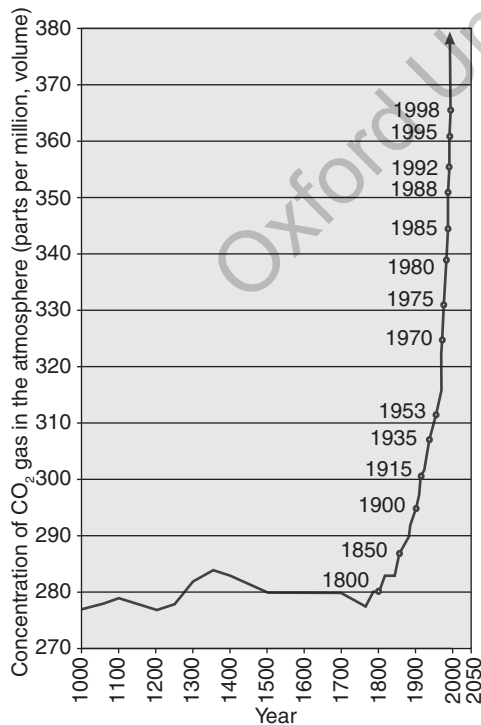


FIGURE 1.4 Growth of Carbon Dioxide Emission

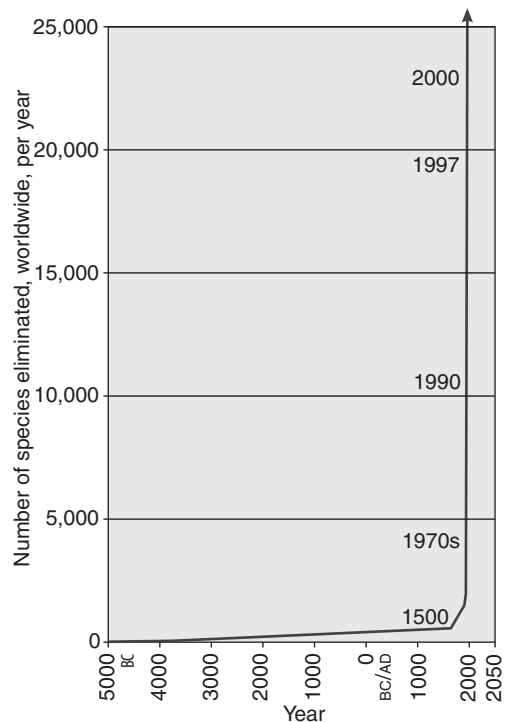
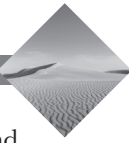


FIGURE 1.5 Growth in Loss of Species



race to consume more, we are using up the earth's finite resources like topsoil, water, oil, and forests far faster than natural processes can regenerate them.

Are the Carbon Dioxide Emissions Too Much?

The concentration of carbon dioxide gas in the atmosphere started increasing exponentially since 1800 and the trend continues unabated. The main reason is the burning of **fossil fuels** like coal and oil. Excessive emissions of carbon dioxide (and other such gases) have reduced the earth's capacity to radiate heat and led to global warming and climate change. We will discuss this issue in Chapter 14.

Are We Losing Species Fast?

There have been **mass extinctions** on earth caused by natural changes but they occurred over hundreds of years. For millions of years, the number of extinctions per year seems to have been very low. The ascendance of monoculture and the massive clearing of tropical forests during the last four centuries have decimated plant and animal species. Many biologists believe that we have now entered the fastest mass extinction rate in earth's history. We will cover the enormous negative impact of species loss in Chapters 9 and 10.

Why should these quantities spike over the last two or three centuries?

The reason is that there has been a fundamental change in the man–environment relationship.

How has the Man–Environment Relationship Changed?

This change began with the Scientific and Industrial Revolutions that occurred in Europe in the sixteenth and seventeenth centuries. Man's new attitude towards nature came from the **Idea of Progress** which is based on these beliefs:

- Humans are a superior species and can indefinitely exploit nature.
- Our progress towards a better life would be linear and continuous.
- Science and technology would help us in this quest for ceaseless progress and development.

Through colonialism and other ways, the Idea of Progress was conveyed to large parts of the world. Today, most countries swear by this notion of growth and development through science, technology, and industrial expansion.

We went on exploiting nature so rapidly that we are now living beyond our means. Our '**Ecological Footprint**' is getting larger and larger.

What is Ecological Footprint?

Assume that you live in a small house in a city. Let us say that the house is surrounded by a small garden and there is a compound wall that marks your plot of land. Can you isolate yourself in your home and continue to live indefinitely? You cannot, since you need many things from outside: food, water, material of different sorts and so on. Your garden may give you some vegetables, but it cannot provide you all the food items you need. There may be a well on your land, but the water may not be potable and you may have to depend on outside sources for drinking water.

Suppose we ask the question: How large a land will you need just to sustain yourself completely? That area is your Ecological Footprint.

Key Idea Ecological Footprint is the amount of biologically productive land and sea area required to sustain indefinitely an entity such as a person, a city's population, a country, etc. It accounts for the energy, food, water, and materials that the entity consumes and the wastes that it creates.

Let us do a mental experiment. Take the physical area of a city like Chennai and cover it with a huge glass hemisphere. We let in sunlight, but we do not allow any material to enter or leave the enclosure. How long will the city survive? Not many days!

The city cannot produce enough food for all the people. There will be severe water scarcity because the tankers from the surrounding villages will stop entering the city. The enormous amount of solid waste generated every day cannot be sent away or dumped into the sea. The air trapped in the hemisphere will soon become so polluted that people will find it difficult to breathe. The '**Carrying Capacity**' of the city area is not sufficient to sustain the lives of the population.

Suppose we are able to expand the size of the glass hemisphere to take in more and more of the surrounding area. Assume also that this area has diverse natural resources like a mini-earth. We can now ask another question: How large should be the area covered, if we want the city to survive indefinitely on the land, water, and energy resources available within the hemisphere? That area is the Ecological Footprint of the city.

Most cities have huge needs and draw their requirements from a very large area surrounding the city. The Ecological Footprint of any large city is many, many times larger than its actual area. Similarly, we can talk about the Ecological Footprint of a country. Or, we can compare the Footprint of a citizen of US with that of an Indian citizen.

We can express Ecological Footprint either in units of area or as the ratio of the area required to the actual area of the entity. For example, if a city requires for its survival an area three times its geographical spread, then its Ecological Footprint is three.

How is our environmental crisis connected to the idea of Ecological Footprint?

The larger the Footprint, the more is the consumption of natural resources and the more is the environmental degradation. Most of the world's cities and many developed countries have Footprints greater than one.

What is the Ecological Footprint of Humanity as a Whole?

The answer may surprise you. Humanity's Ecological Footprint is more than 1.5. That is, we now require 50% more than the earth's area to sustain our consumption of natural resources! Our Footprint is also increasing steadily.

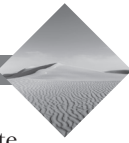
How is that possible? Common sense tells us that we could not be using resources from an area larger than that of the earth! We have only one earth. If our Footprint is 1.5, how are we surviving at all?

We survive because each year we are using up more than our annual share of the earth's resources. By June or so, we use up ecological resources that the earth regenerates in the whole year! The rest of the year, we survive by dipping into our quota of the future.

We draw more water from the ground than the amount of natural recharge. We catch fish faster than the rate at which they can re-populate. Our logging of trees is faster than the rate at which new trees grow.

Key Idea Humanity's Ecological Footprint is already more than 1.5.

Instead of living within the 'annual interest' that nature gives us, we have begun using up our 'natural capital'. In a sense, we are using resources that rightly belong to our children and grandchildren. We are living beyond our means.



In general, we are using resources faster than they can regenerate and creating waste faster than it can be absorbed. This is called ‘ecological overshoot’. While this can be done for a short while, overshoot ultimately leads to the drastic depletion of resources on which our well-being depends.

Another reason why humanity survives ecological overshoot is that the poorer people on earth consume very little resources. The rest of us consume their share too!

What is Carrying Capacity and How does It Relate to Ecological Footprint?

Carrying Capacity refers to the maximum population of a species that a given land or marine area can support. It is concerned about the present and the future. We can calculate the Carrying Capacity of many non-human species that have easily defined and consistent needs of consumption. For humans, however, calculating the Carrying Capacity is more difficult. That is because human resource consumption, standards of living, and ‘wants’ (as distinct from ‘needs’) keep changing over time and space. The productivity of the **biosphere** and the impact of advances in technology cannot also be easily predicted.

Ecological Footprint, on the other hand, is only concerned with the present and past years. Instead of asking how many people *could* be supported on the planet, the Ecological Footprint asks the question: How many planets were necessary to support all of the people that lived on the planet in a given year, under that year’s standard of living, biological production, and technology? This is a question that can be answered through the analysis of available data.

What has the World Done about the Environmental Crisis?

Even by the 1960s, the adverse environmental impact of unbridled economic growth was becoming clear. Books like Rachel Carson’s *Silent Spring* (1962) set the tone for an environmental movement.

The UN Conference on Human Environment in 1972 held in Stockholm was the first international initiative to discuss environmental problems. In 1983, the UN set up the World Commission on Environment and Development (WCED) with Gro Harlem Brundtland of Norway as the Chairperson. The WCED Report, called *Our Common Future*, emphasized the need for an integration of economic and ecological systems. The Commission supported the concept of ‘**Sustainable Development**’.

What is Meant by Sustainable Development?

The WCED Report gave the following definition:

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

This definition implies that economic development and **environmental conservation** could go together. Is this possible or is it just a dream? We will return to this question toward the end of the book (Chapter 19). After we discuss the diverse aspects of the environmental crisis and the possible solutions, we will be in a better position to examine the concepts of sustainability and sustainable development.

What Happened after the Stockholm Meeting?

After Stockholm, the major effort was the UN Conference on Environment and Development (UNCED), called Earth Summit, held in 1992 in Rio de Janeiro, Brazil. Attended by more

than 100 Heads of State and 30,000 participants, UNCED came up with several documents including:

- The Rio Declaration on Environment and Development listing 27 principles of sustainable development
- *Agenda 21*, a detailed action plan for sustainable development in the twenty-first century
- The Convention on Biological Diversity

The implementation of the Rio agreements, however, was very poor. Two more such conferences followed, one in 2002 (Johannesburg, South Africa) and the other in 2012 (Rio de Janeiro again). These conferences came up with more modest but concrete plans of action. But even such plans have mostly remained on paper.

Could We Define Environmental Studies and Related Terms?

Generally, there are two ways in which we use the term ‘environment’. In one, the term refers to what surrounds an entity. Any entity, say a person, any living **organism**, a citizen, a company, etc., has a certain environment. We thus talk of the home environment, the business environment, the political environment, etc.

In the second way, we use the word to mean just the natural environment: the air, water, soil, living beings, plants, trees, mountains, ocean, etc. The Oxford Advanced Learner’s Dictionary defines *environment* as ‘the natural world in which people, animals, and plants live’. This book deals with this natural environment.

An entity interacts with its environment, that is, it influences and is influenced by the environment, positively or negatively. For example, the natural environment affects human beings. We in turn have an impact (often a negative one) on the environment.

Ecology is the science that studies the relationships between living things and the environment. It is often considered to be a discipline of biology.

Environmental Science is the systematic and scientific study of the environment and our role in it.

What then is **Environmental Studies**, which is the subject of this book? The two terms, *Environmental Studies* and *Environmental Science*, are often used interchangeably, but we could make a distinction.

Environmental Studies can be defined as the branch of study concerned with environmental issues. It has a broader canvas than environmental science and includes the social aspects of the environment. It does deal with science where necessary, but at a level understandable to the non-scientist.

Why do We Say that Environmental Studies is an Interdisciplinary Subject?

The subject of environment is inherently interdisciplinary. We study the complex relationships that exist in our natural environment among people, animals, other organisms, water, soil, air, trees, ocean, and so on. The interconnections are numerous and involve many different disciplines. We need inputs from diverse disciplines such as biology, botany, zoology, soil science, technology, oceanography, atmospheric science, economics, sociology, anthropology, and ethics.

A simple rule to remember is that everything in this world is connected. A single act of ours could have unexpected effects. What happened to vultures in India is an example (Box 1.5).


BOX 1.5 CONNECTIONS: Vultures, Cows, Wild Dogs, and Rabies


Vulture: The world's most efficient scavenger
Credit: IndiaPicture/Mahatta Multimedia Pvt. Ltd

How can there be any connection between vultures, cows, wild dogs, and the incidence of rabies? Here is a remarkable story of environmental connections: a great tragedy, the unravelling of a mystery, and some hope.

In the early 1990s, there were at least 80 million vultures in India and Pakistan. One could see massive flocks of vultures in the sky. Yet, within a decade the vulture population declined by 97–99%. How did it happen?

After examining hundreds of dead birds, scientists discovered that the vultures were dying of kidney failure. Why did the kidney fail? Due to the drug diclofenac! The vultures were eating dead cows and the cows had been given diclofenac, a low-cost painkiller. It turned out that even a small amount of diclofenac was deadly to vultures.

The vulture is the world's most efficient scavenger, but it is also a slow breeder. It lays just one egg every year. Thus the breeding could not match the speed with which the vultures were dying.

Now comes the unexpected connection in the story: When the vulture population declined, wild dogs started eating the dead cows and their population exploded. They also picked up the rabies virus from the cows and transmitted them to other dogs. Rabid dogs started biting villagers and India ended up having the highest rate of human rabies in the world, resulting in about 35,000 deaths a year. (The vultures, with their strong stomach acid and high body temperature, can destroy corpse pathogens such as the rabies virus.)

The story continued: The growing wild dog population was easy prey for leopards, which began entering villages to hunt them. As a result, the leopard population also increased dramatically. There were more man–leopard encounters and many more people were killed.

Another side story: The Parsis leave their dead for vultures to consume and now there were too few vultures to carry out the task!

The story ends with some hope: In 2006, India, Pakistan, and Nepal banned the use of diclofenac for cattle. Meanwhile, Vulture Conservation Centres were also established. As a result, the vulture population in India did not decline during 2007–2011 and may have even increased slightly.

Why should You Study Environmental Studies as a Subject?

- Due to the unprecedented environmental degradation, you will soon be living in a very different and difficult world. You must understand the nature and severity of the crisis and your role in it.
- You should move from a linear thinking to systemic thinking that recognizes complex interactions and natural cycles in the world.
- Finally, you must find out what you can do to mitigate the impact of the crisis and how you can join the worldwide movement to save the planet and humanity.

Is There Hope for the Future?

While this book describes the environmental crisis, it also contains many stories of hope, of successful efforts by individuals, voluntary groups, international organizations, and even governments.

Positive actions here and there are not enough, however. We must act individually and collectively to save the planet and the human species through sustainable development.

Ultimately, it is a question of changing one's mindset and taking greater care in the use of natural resources. If that happens to a sufficiently large number of people, we may yet begin to manage the resources in a wise and sustainable way. We will return to this question in the final chapter of the book.

REVIEW: A SUMMARY OF THE KEY POINTS

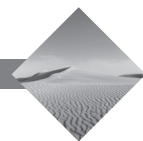
- Environmental indicators show that the world is facing a global crisis.
- Climate change is the defining issue of this century. It is the biggest threat we have ever faced.
- We are the cause of the crisis. We consume natural resources at an ever-increasing rate, without giving nature time to regenerate them.
- We also pollute the world so much that nature cannot absorb all of it.
- Our unsustainable way of living can only lead to a catastrophe.
- The environmental crisis is rooted in our attitude of domination and exploitation of nature, based on the Idea of Progress.
- Many phenomena like population and consumption have been growing exponentially over the past 200 years or so. This has never happened before.
- The concept of Ecological Footprint expresses the amount of land needed to sustain the lifestyle of an entity—a person, a city, a country, etc.
- Humanity's Ecological Footprint is already more than 1.5. That is, we now require 50% more than the earth's area to sustain our consumption of natural resources.
- There have been several international conferences over the issues of environment and development, but the implementation of the agreements has been poor.
- Any study of the environment has to be an interdisciplinary one.
- If we join forces and change our ways of living, we can still stop the destruction and save humanity.

EXERCISES

Objective-type questions

In each case below, choose the best answer out of the given set of choices:

1. What describes best the water and sanitation situation?
 - (a) About 10,000 villages in India are without a single source of drinking water.
 - (b) 50% of the world population lacks sanitation facilities.
 - (c) 65% of the world population suffers from water stress right now.
 - (d) 1.3 billion Indians do not get clean water.
2. Which of the following statements is true?
 - (a) Nature can absorb the waste and pollution that we create.
 - (b) Even if we continue with our current ways of living, nature will, in due course, take care of the problems that we create.
 - (c) Our current consumption levels are unsustainable.
 - (d) Natural resources have no limits.
3. Assume that there is a quantity that increases exponentially and we draw the graph of the quantity against time. How would you best describe the curve?
 - (a) Its increase is directly proportional to the time. When the time doubles, the quantity also doubles.
 - (b) It is a flat curve.
 - (c) The curve goes up and down.
 - (d) Its value doubles over a fixed time period and the curve becomes steeper all the time.



4. Humanity's Ecological Footprint
 - (a) already exceeds the area of the earth.
 - (b) cannot exceed the area of the earth.
 - (c) now equals twice the area of the earth.
 - (d) is less than the area of the earth.
5. Which of the following was **not** a conference on environment?
 - (a) Stockholm UN Conference on Human Environment in 1972.
 - (b) UN Conference on Environment and Development held in 1992 in Rio de Janeiro.
 - (c) World Summit called Rio+10 held in Johannesburg in 2002.
 - (d) Conference of the G8 countries held in Sochi, Russia, in 2014.
6. What is the most important environmental issue of this century?
 - (a) Scarcity of water
 - (b) Climate change
 - (c) Population growth
 - (d) Shortage of petroleum

Short-answer questions

1. What are the two main causes of the environmental crisis?
2. Explain the concept of Ecological Footprint through an example.
3. List the major international conferences held on environment and development.

4. Define the term 'sustainable development'.

Long-answer questions

1. Explain the root cause of the current environmental crisis through the four spikes.
2. Give a non-mathematical explanation of exponential growth and compare it with linear growth. Give one or more examples.
3. Humanity's Ecological Footprint is 50% more than the earth area. How then are we carrying on our 'business as usual'?
4. Why do we say that any study of the environment becomes an interdisciplinary one?
5. Find out the current status of each of the environmental indicators listed in this chapter. Have any indicators changed for the better?

Think critically: Deeper questions for reflection and discussion

1. There is a view that all our problems and our domination over nature started when we started practising agriculture about 10,000 years ago. Examine this view and give arguments in favour and against.
2. In your opinion, what should be the difference in the way the two subjects, environmental science and environmental studies, are taught to undergraduates?
3. Why are many environmental problems so difficult to solve?



ACTIVITIES

Act: What you can do to conserve the environment

Practical ways of helping to save the environment are given in most of the succeeding chapters. To begin with, you could do the following:

1. Make a resolution that you would take one small action every day to conserve the environment. Act on the suggestions given in this book.
2. Join a local environmental group or voluntary organization and work with them at the local level.
3. Try to reduce your Ecological Footprint by examining the source of everything that you consume. Can you grow some vegetables and fruits in your backyard or terrace? Can you collect the rain water that falls on your roof?

Organize together: Eco-club activities and projects

This is the start of a new semester or academic year. Make a good beginning by setting up an eco-club in your college. Write down its aims and possible activities. Elect a secretary and a small committee. In later lessons, there are suggestions for eco-club activities.

You can also get ideas from the UN special programme for youth, called TUNZA. Access the website www.unep.org/tunza/youth.

Learn by doing: Idea for fieldwork

Study your neighbourhood, your town, or your ancestral village. What are the key environmental issues faced by the place? What are the conflicting interests in each case?



ENJOY AND EDUCATE YOURSELF



1. Watch the movie *The Day the Earth Stood Still* (2008), starring Keanu Reeves. The film is a powerful reminder that there are consequences to wilful ignorance and inaction about the environmental crisis.
2. Read *Ecotopia: The Notebooks and Reports of William Weston* (1975), a novel by Ernest Callenbach, which describes an ecological utopia. This novel was influential in the environmental movement.



Books

- Ayres, Ed 1999, *God's Last Offer: Negotiating for a Sustainable Future*, Four Walls Eight Windows, New York. (on exponential growth)
- Carson, Rachel 1962, *Silent Spring*, Indian Edition, Other India Press, Goa.
- CSE 2000, *Our Ecological Footprint: Think of Your City as an Ecosystem*, Centre for Science and Environment, New Delhi.
- Mason, Colin 2003, *The 2030 Spike: Countdown to Global Catastrophe*, Earthscan, London. (on exponential growth)
- Narain, Sunita et al. (eds) 2015, *State of India's Environment—2015*, Centre for Science and Environment, New Delhi.
- Wackernagel, Mathis and William E. Rees 1996, *Our Ecological Footprint: Reducing Human Impact on the Earth*, New Society Publishers, Gabriola Island, Canada.
- WCED (World Commission on Environment and Development) 1987, *Our Common Future*, Oxford University Press, Oxford.

Websites

There are hundreds of websites on environmental issues. Here is just a small sample:

- United Nations Environment Programme: www.unep.org
- Intergovernmental Panel on Climate Change: www.ipcc.ch
- UNEP Environmental Knowledge for Change: www.grida.no
- Magazine showcasing environmental solutions in action; Ideas, information and inspiration to change the world: www.ensia.com
- Scientific news, articles, current events: www.livescience.com/environment/
- A daily update on a warming world: <http://www.climate-news-network.net/>

Films

Some examples out of the very large number of environmental documentaries:

- *The 11th Hour* takes a look at the state of the global environment including visionary and practical solutions for restoring the planet's ecosystems, by Leonardo DiCaprio.
- *What a Way to Go: Life at the End of Empire* about the current situation facing humanity; discusses issues such as climate change, population overshoot, and species extinction, by Sally Erickson and Tim Bennett.
- *The Many Faces of Madness*, on ecological degradation in India, by Amar Kanwar.
- *Vanishing Vultures*, on the vulture story, by Mike Pandey (Box 1.5).



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- The story of Kalahandi: From forests to famine
- Connections: Get rid of malaria, but invite the plague
- Connections: Drink coffee in US and make the songbird vanish in South America!
- Additional text and other recommended references, websites, and films