Environmental Science

The Natural Environment and Human Impact

Andrew R.W. Jackson & Julie M. Jackson

edition 2

Prentice Hall

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second edition

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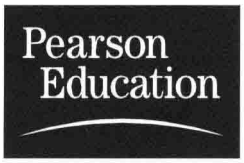

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To the memory of
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Preface to the second edition

Environmental science is a rapidly developing field. Since the publication of the first edition of this text, in 1996, a significant number of new environmental issues have come to the fore. This new edition of *Environmental Science* therefore includes a sizeable amount of new and topical material. Most notably, this takes the form of a new chapter (Chapter 10) that examines the exploitation of biological resources, together with four new case studies covering BSE, genetically modified crops, arsenic contamination of drinking water in the Ganges Delta, and the problems surrounding the disposal of radioactive waste. New material is also incorporated within other chapters, for example the El Niño–Southern Oscillation (ENSO), described in Chapter 4, and endocrine-disrupting substances, discussed in Chapter 14.

Additionally, other areas that were covered in the first edition have developed significantly since 1996 and consequently needed reappraisal. For example, the Montreal Protocol has been strengthened over recent years and its implementation is now resulting in noticeable effects (Chapter 15).

We also took the opportunity, afforded to us by the preparation of a new edition, to improve the overall accessibility of the book. We have sought to achieve this by incorporating a number of new features. These include learning objectives at the start of each chapter, colour plates, a glossary, a *Lecturers' guide* available to adopters from the publishers, and a supporting website (http://www.booksites.net).

ARW Jackson
JM Jackson
December1999

Preface to the first edition

Modern techniques of environmental science allow us to explore our surroundings in ways that were unimaginable until relatively recently. These explorations have not only revealed the natural world in ever finer detail, they have also provided evidence to suggest that the activity of humans is, for the first time, causing changes to the environment on a global scale. Heightened interest in the nature and quality of our surroundings is reflected in the growing amount of published work concerning environmental issues, both in the press and in more specialist literature.

This book was written to provide a clear and authoritative introductory environmental science text. It strives to bridge the gap between the popularist and specialist environmental publications. It introduces the reader to the basic concepts and vocabulary necessary to explore complex environmental issues and problems.

Environmental science will primarily be of use to first-year undergraduate students of the environmental sciences, including environmental biology and environmental chemistry. However, it will also serve as a reference text for students of related disciplines such as environmental studies and environmental management. The text is constructed in a concise and coherent manner, making extensive use of boxed material, both to explain basic theory and to provide illustrative examples. In order to further enhance the student's learning experience, end of chapter problems and a selection of environmental case studies are included. The latter are intended to provide a starting point for further, independent, investigation into the environmental issues raised.

The book is divided into two main parts: **The Natural Environment** (Chapters 1–10) and **Human Impact on the Natural Environment** (Chapters 11–16). In the first of these, the nature and chemical behaviour of matter is explored, as are the major features and processes of the lithosphere, hydrosphere, biosphere and atmosphere, and the interactions between them. In the second part of the text, the impact of human activities upon the environment, through the exploitation of natural resources and the production of pollutants, is explored in depth. Attention is given in the final chapter to the issue of waste management.

Environmental science is concerned with the presentation of factual information and its scientific interpretation. It does not attempt to deal with either the ethical or legal problems associated with environmental issues. While techniques of environmental management are introduced where relevant in the latter part of this text, this is not a major theme of the book. Readers interested in this aspect of environmental science may wish to read Timothy O'Riordan's book *Environmental Science for Environmental Management* (second edition, Prentice Hall, 2000).

We would like to take this opportunity to explain some of the policies that we have adopted concerning specific units, nomenclature and symbolisms. When writing this book we have used SI units, except where other units are in more common usage in the general literature of environmental science. Conversion factors between SI units and their non-SI equivalents are given in Appendix 2. When referring to specific organisms, it has been our policy to refer to them by their common names, citing their Linnean Latin binomial at first mention only. When using half-cell equations we have represented oxidations as such, rather than as reverse reductions. We have done this to avoid the necessity for the subtraction of half-cell equations when generating full-cell equations. In accordance with convention, we use only reduction potentials when calculating cell potentials. In accordance with the convention used in physical chemistry, units and multiples appear after a solidus (/) in the column headings of tables and the labels on the axes of graphs.

ARW Jackson
JM Jackson
April 1995

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A special mention must be made of our family for their support and encouragement. In particular, we would like to thank our sons, Tom and Hugh, for their patience and understanding during the writing of this new edition.

ARW Jackson
JM Jackson
December 1999

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Introduction

Environmental science is the systematic study of the natural and man-made world. It is now a major discipline, reflecting our growing concern about the impact of human activity on the natural world.

The environment may be conceptualised as being composed of a number of interconnected processes and phenomena. These include the formation of rocks, the climate system, the cycling of biologically important elements and the interactions between organisms and their surroundings.

In part, environmental science involves the identification, measurement and classification of these processes and phenomena. Importantly, it also encompasses our attempts to rationalise their existence and to predict how they will alter in the future. Environmental science therefore, like all other sciences, involves detection, classification, measurement, the establishment of experimentally verified laws by hypothesis formulation and testing, and the generation of predictive models.

Environmental science is of importance, not only because it informs us about the world in which we live, but also because it enables us to address more effectively many of the pressing issues that confront the modern world. For this reason, environmental science is increasingly seen as a vital tool in establishing the ground rules by which the environment may be more effectively managed in the future.

The first part of this book (Chapters 1–9) explores the major attributes of the environment in the absence of human activity. It is largely devoted to a detailed examination of the salient characteristics and interactions of the lithosphere (rocks), hydrosphere (water), biosphere and atmosphere (Chapters 3–9). In recognition of the varied backgrounds of the readership, the basic scientific concepts that are required for an understanding of the chemical processes that are central to the environment are set out in Chapters 1 and 2.

The first nine chapters of the book not only describe the natural environment, they also form a firm foundation on which the second part of the book is built. Within the second part, the human impact on the natural environment is examined. In Chapters 10–13, the nature of both finite and renewable resources is explored, together with the processes and patterns of their exploitation. Specifically, we examine biological resources, agricultural land use, mineral extraction and energy production. The consequences of this exploitation are reviewed both within Chapters 10–13 and in Chapters 14 and 15 where the major types of water and atmospheric pollution are described. This part of the book closes with an introduction to the principles and practice of waste management (Chapter 16).

Within this book, the reader will find scientific explanations of the causes and potential ramifications of the major environmental issues that currently face us. For example, in Chapter 15, we explore the greenhouse effect and climate change, stratospheric ozone depletion and the phenomena of acid rain and smog. The environmental impact of agricultural land use, including deforestation, salinisation, soil erosion and desertification, are covered in Chapter 11. Also, the importance of the world's biological resources and the consequences of their exploitation are examined in Chapter 10.

This book aims to present a dispassionate, objective and authoritative introductory review of both the natural environment and the impact of human activity on it. It is designed to introduce the reader to the key concepts and vocabulary of environmental science. This learning experience is reinforced by the inclusion of boxes that expand on and illustrate the basic concepts introduced in the text. For ease of access, each of these boxes is assigned to one of the following categories: mini case studies, tool boxes, or further information boxes. To consolidate understanding, each chapter commences with a statement of objectives and closes with a series of problems. Topical case studies follow each of the chapters in the second part of the book (Chapters 10–16). These are designed to stimulate the reader to further investigate and evaluate specific environmental issues, thereby facilitating the development of independent study. A glossary is provided at the end of the text that contains a selection of key terms with which the reader may not be familiar. Additionally, a wider range of key terms is highlighted in the index, directing the reader to those parts of the main body of the text where the terms are either defined or described.

This text is primarily designed for first-year undergraduates of the environmental sciences, including environmental chemistry and environmental biology. However, it will also be of value as a source of background material to students of related disciplines, such as environmental management or environmental studies.

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