ENVIRONMENTAL SCIENCE

the Way the World Works

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PRENTICE-HALL, INC.
ENGLEWOOD CLIFFS, NEW JERSEY 07632

Library of Congress Cataloging in Publication Data

Nebel, Bernard J
Environmental science, the way the world works.

Includes bibliographies and index.
1. Ecology. 2. Human ecology. 3. Pollution—Environmental aspects. I. Kormondy, Edward John, 1926- II. Title.
QH541.N39 574.5 79-23687
ISBN 0-13-283002-7

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Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

Editorial/production supervision: *Paul Spencer*
Manufacturing buyer: *Edmund W. Leone*

Prentice-Hall International, Inc., *London*
Prentice-Hall of Australia, Pty. Ltd., *Sydney*
Prentice-Hall of Canada, Ltd., *Toronto*
Prentice-Hall of India Private Limited, *New Delhi*
Prentice-Hall of Japan, Inc., *Tokyo*
Prentice-Hall of Southeast Asia Pte. Ltd., *Singapore*
Whitehall Books Limited, *Wellington, New Zealand*

preface

Despite an overall decline in college enrollment, our Environmental Science course at Catonsville Community College has grown from one section (24 students) in 1975 to six sections per semester in 1979. This growth has been almost entirely the result of word-of-mouth advertising. Typical student responses: "This is the most significant course I have ever taken." "Why isn't this a required course?" "I think all students should take this course." The feedback from students to advisors has been such that advisors now recommend the course to students who are undecided as to what to take to fulfill their science requirement. Yet, the course is not just "motherhood and apple pie" or an easy way to obtain three hours' credit. While achieving student popularity, it has also gained the respect of the science faculty as a substantive course with a definite body of information that is highly pertinent to understanding and coping with today's world. The course and this book, *Environmental Science: The Way the World Works*, have developed together. The informational core of our course is embodied in this text. I hope that it may prove as useful to others as it has to us and that it may play some role in helping to solve our environmental problems.

The level of presentation in *Environmental Science: The Way the World Works* is aimed at college students (non-science majors) or lay readers with little or no background in science. (Our environmental science course has no prerequisites.) However, the course has proved valuable to science majors as well, because it covers many topics and makes many interdisciplinary connections which are not generally brought out in traditional courses. It also serves as a fundamental course for those with career interests related to conservation and environmental science.

The great strength of *Environmental Science: The Way the World Works*, a factor which I believe is largely responsible for the success of our environmental science course, is its clear, concise, coherent organization and presentation. Each chapter (covered in about one week of the course) starts with background and develops an understanding of basic principles in an easily grasped manner; then it continues to build on these in a logical, step-by-step fashion to an overall understanding of complex issues.

A *Concept Framework* at the front of each chapter is a central and unique feature which is instrumental in helping the student to develop understanding. The Concept Framework consists of an *outline* of the chapter and parallel *study questions*. Each section of the outline is keyed to the text by page number and section heading so that the information can be found easily. Students report that these Concept Frameworks are a great aid in focusing and guiding their study efforts so as to achieve mastery of the material. They may also be used by the instructor in guiding class discussion and in formal evaluation of the learning process. (Multiple-choice questions supplied in the *Instructor's Manual* have been constructed and keyed to the study questions in the Concept Frameworks.)

The Concept Frameworks and the text in general, however, do not lock one into a particular track of presentation. Indeed, the Concept Frameworks may serve to facilitate cutting and trimming and/or adding additional material at pertinent locations as may be desired.

Throughout the text, complexities have been sorted out into a logical progression and technicalities have been boiled down to give clear, straightforward emphasis to basic trends and directions. Each important point is illustrated with an example to help clarify the idea; the numerous photographs and line drawings have all been chosen or created to help convey particular points. However, the use of superfluous numbers and references has been avoided, because it is felt that at the introductory level these often tend to clutter rather than to clarify issues. The result is a text that is easy to read, without resorting to verbal gimmicks or talking down to readers.

Furthermore, in concentrating on a clear development of basic concepts, *Environmental Science: The Way the World Works* provides a logical framework into which examples of current and/or local significance can readily be inserted, and it constructs a strong, basic foundation to which more detailed information can be added. Thus, this text and current events relating to environmental problems will readily complement each other regardless of time or place.

The theme stressed throughout *Environmental Science: The Way the World Works* is that every system involving life is dependent upon maintaining balances. An ecosystem approach is used to show that stability of living systems depends upon balance between nutrient gains and losses, between energy inflow and outflow, and between births and deaths within populations. Against this backdrop, various aspects of the human system such as our use of soils, our disposal of wastes, our use of resources, land, and energy, and our population are shown to be out of balance—situations which are unsustainable. Then, in each case, discussion proceeds to point out the direction that changes must take in order to bring about balance and assure sustainability, indeed survival, of our human system. Finally, suggestions for practical courses of action are discussed.

Such single-theme approaches could become pedantic and boring. However, while sorting out complexities and boiling down technicalities, care has also been taken not to oversimplify complex issues. For example, the economic realities which impede recycling and pollution control are described as well as the ecological virtues of these practices. The legal problems of implementing land use controls are set forth along with the need for such controls. With respect to future availability of resources, arguments of "limitists" and "cornucopians" are presented in a point and counterpoint fashion. There is a thorough discussion of nuclear power, giving both pros and cons. Possibilities of increasing world food production are contrasted with limiting factors. In addition to avoiding oversimplification, such contrasting of points and counterpoints lends an air of intrigue to the text which students report is highly valuable in maintaining interest as well as deepening their understanding of complex issues.

The emphasis on development of concepts also provides a unique approach to the vast, heterogenous subject of pollution. Pollution is not addressed as a single issue in one or two chapters. Instead, in the course of building an understanding of principles relating to soils, the water cycle, domestic wastes, industrial wastes, and pest control (Chapters 4-8, respectively), the book shows how traditional attitudes and

management practices lead to pollution and other forms of degradation of air, water, and soil. This approach makes it more clear that solutions must involve fundamental changes in attitudes and management practices rather than just "adding on more filters."

The ecosystem approach used in *Environmental Science: The Way the World Works* also serves to develop an understanding of many issues that are generally considered scantily, if at all, in other environmental science texts. For example, this book develops an understanding of the theory of evolution by natural selection and then uses it to integrate the ideas of adaptation, ecosystem balance, succession, and the overall position of humans in the biosphere. Concepts of the atomic-molecular nature of air, water, minerals, and solutions are carefully built up and carried into a discussion of plant and animal nutrition. This leads to a thorough understanding of basic nutrient cycles, and it also provides the basis for a more sophisticated understanding of subsequent topics such as soils, pollution, resources, and energy. Concepts concerning plant-soil interrelationships are developed and used to build an understanding of how various agricultural practices may lead to degradation or improvement of soil and, in turn, affect future productivity. Environmental degradation resulting from urban sprawl and the problems of urban blight are brought together in an overall picture of urban-suburban migrations and changing lifestyles.

Lastly but most importantly, the systematic approach of *Environmental Science: The Way the World Works* enables students to see clearly the connections between their own attitudes, actions, and lifestyles and the various environmental problems which exist, and thus establishes the motivation and basis for change.

BERNARD J. NEBEL

acknowledgments

As a student, I must confess, I never considered the acknowledgments an important part of a text. After struggling through the writing of this book, however, I have gained a new and profound understanding of the truth that lies behind an all too simple statement that such an accomplishment would not have been possible were it not for the hard work and faithful support of many others along the way. I now hope that all will read this short piece and know my sincere thanks and indebtedness to the following people who helped me bring this work to fruition:

My wife, Jean, who played many roles from proofreader and critic to general manager, keeping the entire project on track while at the same time keeping a stable home environment. Edward J. Kormondy, who critically reviewed the manuscript and made extensive editorial suggestions that helped in the final shaping of the text. Emily McNamara, a talented art student, who spent hundreds of hours converting my ideas into sketches. David Hunley, who made his way through countless government offices and news agencies searching for and finding appropriate photographs. Mary Beyer, who not only typed the final draft of manuscript but also took a real interest in it. Likewise Terri Leonnig and Lynn Carr, who typed earlier drafts. Kathy Yaw, a most enthusiastic student who performed many miscellaneous chores along the way. Olive Blumenfeld, an excellent secretary who kept everything at work running smoothly and, along with Joan Truby and Byron Daudelin, helped in many ways at critical times. Kai A. Nebel, for his constant encouragement and support. Jack Anderson and Bruce Welch, for lending their professional expertise to the review of chapters.

There are also many others who deserve credit, but I hope that they will forgive me for not mentioning their names individually. My colleagues at work read and commented on and also provided valuable discussion concerning various parts of the manuscript. Many people in government and private agencies were very helpful in providing me with various publications and reports. The work of countless scientists provided the information used.

Finally, thanks must go to all my students, who provided the reason for writing this book—to my good students, who make the effort seem worthwhile, and also my less good students, who continually provide a challenge to try harder.

BERNARD J. NEBEL

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Introduction

One of the most valuable features of human intelligence is the ability to relate the past, present, and future. Looking back, we can see how one event has led to the next and how the present is a product of what has occurred in the past. Even more importantly, by recognizing how one event leads to another, we can extrapolate current trends and thereby gain some insight into what the future may be like. What can be foreseen for the next 10, 20, or more years?

Any prediction of the future must be considered far from reliable because there are countertrends as well as trends; our future will be drastically different depending on which of these trends prevail. For example, a general trend of the past 30 years has been toward steadily increasing affluence, with more and more technological conveniences. We might hope and expect that this trend will continue. However, increasing shortages of the energy which is necessary to support our technological society form another trend, which could result in a tragic reversal. But energy supplies are declining only with respect to conventional sources, namely crude oil. The growth of a new trend, the development of solar and wind power, has the potential of eventually providing us with almost unlimited energy.

A second major trend has been the steady advancement of medical technology and treatment, which has led to generally better health, freedom from suffering, and longer life expectancy. Here also, we may expect that this trend will continue into the future. However, there are ominous signs that it may be counterbalanced and reversed by trends of pollution of air, water, and soil which pose increasing threats to human health. But again there is a potential countertrend; increasing recognition and understanding of pollution problems, and development of pollution control strategies, may alleviate pollution problems.

A third area of opposing trends involves the conflict between human population and conservation. The predominating trend of the past and present is one of rapidly increasing world population—births exceed deaths by more than 200,000 every day. In the face of increasing population, natural areas with all their associated wildlife are being obliterated to make room for agriculture and other uses more directly related to supporting humans. At the same time, millions of hectares of land already in agricultural, range, and forest production are turning into wastelands because of poor soil conservation practices. Extrapolating this two-sided trend of increasing population and relative lack of attention to conservation leads to a bleak specter of barren landscapes and massive human famine. But, as before, more than one trend applies. The

technology for birth control is available and there is a growing trend toward its acceptance and use, so that recently the rate of population growth has slowed, although it is still high. Also there is increasing awareness of the need for conservation. Projecting these trends offers some hope for eventually achieving a stable world population.

In short, the crystal ball is very cloudy. Depending on one's frame of mind, one

may envision a bright future in which unending scientific and technological progress continually betters the human condition; or one may see a dismal future in which technological society collapses under the weight of energy shortages, pollution, and overpopulation. Ample evidence exists to support either point of view. But arguing over what is seen in the crystal ball, positive or negative, is really futile. For humans, the future is not a predestined fate that slowly unwinds like string from a ball. *The future will be what we make it!*

We have noted that the present is a product of the past, but past events that have shaped the present were not happenstance events of fate; they were conscious, intentional decisions and actions on the part of humans planning and building for the future. For example, the interstate highway system did not just grow; it was brought into existence through planning, financing, and hard work. It is the result of the efforts of people 25 to 30 years ago who planned, worked toward, and indeed, created a future which is now the present. Likewise our future will depend upon our ability as individuals and as a society to make decisions and take actions that will bring about a future that we desire.

As a starting point it can be assumed that we wish to turn away from those negative trends which threaten our society. But undoubtedly this has long been a general objective. Planners of the past did not intentionally work toward creating the energy crisis, polluting the Earth, overpopulation, and so on. These are the unforeseen side effects of otherwise commendable endeavors. Is there, then, any better hope for the future, or will it always be the case that every "solution" simply creates a bigger problem?

There is no question in my mind. *We can bring about permanent solutions without creating further problems!* However, there must be a difference between past and future efforts. The difference lies in understanding and acting in accord with certain principles of ecology and environmental science. By way of analogy, you may have observed a young child attempting to build a structure in ignorance of basic principles of gravity and support. The structure collapses; the child starts again and the structure collapses again, perhaps causing great anguish and frustration. But of course the child's efforts are bound to fail until basic principles of support are observed. In a way, humankind is still in a state similar to that of the child. We have been building our social-economic-technological structure in ignorance of basic ecological and environmental principles which, while more subtle than gravity, are just as basic in determining the support of all systems involving life. As long as these ecological principles are ignored, environmental problems will persist and survival itself will be in jeopardy.

Fortunately, it is no longer necessary to proceed in such ignorance. Both the hard knocks of experience and the diligent work of scientists and others have clarified the basic principles that must be followed in building an enduring and prospering human system. The objective of this text is to convey an understanding of these principles.