Handbook of Environmental Health and Safety

Principles and Practices

Herman Koren

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Foreword

Over the years, many books have addressed the subject of environmental health. Here is yet another. The questions naturally arise, Why another book on environmental health?; Why at this time?; Why this particular book? The first two questions can be answered together in terms of six phenomena characterizing the past few decades: first, of course, is the spectacular growth of the human population. Population growth accentuates environmental problems and hence health problems. When a second cave man moved in with the first, the various waste products of their respective living processes necessarily impinged upon each other. Obviously, the greater the number of people, the greater the environmental problem — The rate of increase in the world's population has more than doubled since the end of World War II with about 200,000 now being added daily. Concurrent with population growth is greatly increased mobility with a tendency toward concentration in urban areas further exacerbating environmental problems.

A third phenomenon is the knowledge explosion in science and technology bringing countless benefits to humankind, yet resulting in considerable environmental abuse and an ever-growing catalogue of health hazards. Increasingly, the individual is confronted with risks and hazards. As an individual, he is helpless in the face of the chemical and biological pollution of the air he must breathe, of the water he drinks, and of the food he must eat in order to survive. As an individual he cannot control any of these any more than he can avoid them. A fifth phenomenon is the welcomed expansion of the parameters and capabilities of medical and biological science facilitating study of the long-term consequences of exposure to a variety of potential health hazards, including natural and synthetic chemicals in large and minute amounts, audible and inaudible vibrations, and noise. Lastly, there is the very important phenomenon of broad public or consumer education resulting in a justified insistence on the accountability of researchers, manufacturers, vendors, and regulatory agencies.

Any of these phenomena and certainly all viewed together necessarily places the field of environmental health in a new light. This brings us to the third question posed earlier, Why this particular book? The answer is found in its unusual comprehensiveness, as indicated by even a cursory glance at the Contents, and by the very solid background of the author, Dr. Koren, in both practice and teaching. In style this volume is succinct, readable, and direct, and it is augmented with pertinent reference and bibliographic materials. Because of this fortunate combination of qualities, it should serve not only as an excellent basis for newcomers to the field, but also as a valuable survey and reference book for those already engaged in the important practice of environmental health.

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Preface

This handbook is designed to provide a comprehensive, concise discussion of each of the important environmental health areas including: energy, ecology and man, environmental epidemiology, environmental law, air quality management, food protection, insect control, rodent control, pesticides, the chemical environment, environmental economics, human disease and injury, occupational health and safety, noise, radiation, recreational environment, housing, medical care institutions, schools and universities, prisons, solid waste management, water supply, plumbing, swimming areas, sewage disposal, soils, water pollution control, environmental health emergencies, and nuisance complaints.

Sufficient background material is introduced throughout this book to provide students, practitioners, and other interested readers with an understanding of the areas under discussion. Common problems and potential solutions are described; graphs, inspection sheets and flow charts are utilized as needed to consolidate or clarify textual material. All facts and data come from the most recent federal government documents, many of which date from 1978 and 1979. Rules and regulations specified will continue to be in effect into the 1980s. For rapidly changing areas in which the existing material used is likely to become dated, the reader is referred to the appropriate sources to update a given environmental health area or portion of an area as needed. This enhances the value of the text by providing basic and current materials that will always be needed and secondary sources that will enable the reader to keep up to date.

This book is neither an engineering text nor a comprehensive text in each area of study. The purpose of this book is to provide a solid working knowledge of each environmental health area with sufficient detail for practitioners. The text can be used in basic courses in environmental health, environmental pollution, ecology, the environment and man, which are offered at all universities and colleges in the United States and abroad. These courses are generally taught in Departments of Life Science, Geology, Science Education, Environmental Health, and Health and Safety. For general areas of study, the instructor can omit specific details such as Resources, Standards, Practices and Techniques, and Modes of Surveillance and Evaluation. This same approach may be used by Schools of Medicine, Nursing and Allied Health Sciences for their students. This text is also suitable for basic introductory courses in Schools of Public Health, Environmental Health, and Sanitary Science as well as Junior Colleges offering two-year degree programs in Sanitary Science and Environmental Science.

Practitioners in a variety of environmental health and occupational health and safety fields will find this book a handy reference for resolving current problems and for obtaining a better understanding of unfamiliar areas. Practitioners and administrators in other areas such as food processing, water quality control, occupational health and safety, and solid waste management will also find this reference book useful.

High school teachers often must introduce environmental health topics in their classes and yet have no specific background in this area. This book could serve as a text in graduate education courses for high school teachers as well as a reference source.

Public interest groups will obtain an overall view of environmental problems by reading Chapter 1 and the Background and Status, Problems, Potential for Intervention, Resources, and Control sections in each chapter. This volume will also supply a concise reference for administrators in developing nations for it explains tested controls and provides a better understanding of environmental problems, various standards, practices and techniques, and a variety of available resources.

The material divides easily into two separate courses. Course I would correspond to the contents of Volume One and include: Chapter 1. Environment and Humans; Chapter 2. Food Protection; Chapter 3. Food Technology; Chapter 4. Insect Control; Chapter 5. Rodent Control; Chapter 6. Pesticides; Chapter 7. Housing Environment; Chapter 8. Institutional Environment; Chapter 9. Recreational Environment; Chapter 10. Occupational Environment.

Course II corresponding to the contents of Volume Two, would include: Chapter 11. Air Quality Management; Chapter 12. Solid Waste Management; Chapter 13. Private and Public Water Supplies; Chapter 14. Swimming Areas; Chapter 15. Plumbing; Chapter 16. Private and Public Sewage Disposal and Soils; Chapter 17. Water Pollution and Water Quality Controls; and Chapter 18. Environmental Health Emergencies, Nuisance Complaints, and Special Problems.

Since the problems of the environment are so interrelated, certain materials must be presented at given points in order to give clarity and cohesiveness to the subject matter. As a result, the reader may encounter some duplication of materials throughout the text.

With the exception of Chapters 1 and 18, all of the chapters have a consistent style and organization facilitating retrieval. The introductory nature of Chapter 1 and the unusual nature of Chapter 18 do not lend themselves to the standard format.

In Chapter 1, the reader is introduced to the underlying problems, basic concerns and basic philosophy of environmental health. The ecologic, economic, energy, toxicologic and epidemiologic bases provided help the individual to understand his relationship to the ecosystem, to the real world of economic and energy concerns; and to understand the relationship between biological, physical and chemical agents and disease and injury causation. It also provides an understanding of the role of government and the environmental health practitioner in helping to resolve environmental and ecological dilemmas created by humans.

In Chapter 18, the many varied facets of environmental emergencies, nuisances and special problems are discussed. Students may refer to other chapters of the text to obtain a complete idea of each of the problems and the potential solutions.

The format of Chapters 2 through 17 is as follows:

STANDARD CHAPTER OUTLINE

1. Background and Status (Brief)
2. Scientific, Technological, and General Information
3. Problem
   A. Types
   B. Sources of Exposure

C. Impact on Other Problems
D. Disease Potential
E. Injury Potential
F. Other Sources of Exposure Contributing to Problem
G. Economics

4. Potential for Intervention
   A. General
   B. Specific
5. Resources
   A. Scientific and Technical; Industry, Labor, University; Research Groups
   B. Civic
   C. Governmental
6. Standards, Practices and Techniques
7. Modes of Surveillance and Evaluation
   A. Inspections and Surveys
   B. Sampling and Laboratory Analysis
   C. Plans Review
8. Control
   A. Scientific and Technological
   B. Governmental Programs
   C. Other Programs
   D. Education
9. Summary
10. Research Needs
11. Bibliography

- The Background and Status section of each chapter presents a brief introduction and current status of each problem area. An attempt has been made in each case to present the current status of the problem.
- The Problem section is subdivided into several important areas to give the reader a better grasp of the total concerns. To avoid disruption in continuity of the standard outline, the precise subtitles listed may not be found in each chapter. However, the content of the subtitles will be present. The subtitle, Impact on Other Problems, is a constant reminder that one impact on the environment may precipitate numerous other problems.
- The Potential for Intervention sections is designed to succinctly illustrate whether a given problem can be controlled, the degree of control possible, and some techniques of control. The reader should refer to the Controls section for additional information.
- Resources is a unique section providing a listing of scientific, technical, civic and governmental resources available at all levels to assist the student and practitioner.
- The section on Standards, Practices and Techniques is specifically geared to the reader who requires an understanding of some of the specifics related to surveys, environmental studies, operation, and control of a variety of program areas.
- The Modes of Surveillance and Evaluation Section explains many of the techniques available to determine the extent and significance of environmental problems.

- The Control section presents existing scientific, technological, governmental, educational, legal and civic controls. The reader may refer to the Standards, Practices and Techniques section in some instances to get a better understanding of controls.
- The Summary presents the highlights of the chapter.
- Research Needs is another unique section that is intended to increase reader awareness to the constantly changing nature of the environment and of the need for continued reading or inservice education on the future concerns of our society.
- The Bibliography is extensive and as current as possible. It provides the reader with sources for further research and names of individuals and organizations involved in current research.

For readers in need of more in-depth coverage of environmental health topics, four satellite volumes are presently planned for publication; additional monographs will be added as needs dictate. The first three monographs tentatively entitled, *Biological Agents*, *Physical Agents*, and *Chemical Agents* will address the types of agents, respectively, and their relation to humans. The fourth monograph will address the topic of *Resources*.

In *Biological Agents*, the following outline will be used: 1. Name of Disease; 2. Symptoms of Disease; 3. Incubation Period; 4. Etiological Agent; 5. Occurrence; 6. Reservoir; 7. Mode of Transmission; 8. Period of Communicability; 9. Susceptibility and Resistance; 10. Controls.

In the monographs on *Physical* and *Chemical Agents*, the following outline will be used: 1. Name of Chemicals or Physical Agent; 2. Description; 3. Occurrence; 4. Production; 5. Uses; 6. Permissible Exposure Limits; 7. Route of Entry; 8. Hazards; A. Acute; B. Chronic; 9. Controls; 10. Treatment.

The fourth monograph on *Resources* will address, by subject area, many of the vital scientific, technological, civic and governmental resources available, as well as journals and computer services which may be employed by the reader.

We share the earth with numerous other biosystems, some of which affect the health of our species. The human species alone has the intellectual capacity to improve or destroy the planet Earth by the application of science. Only through research, thoughtful application of knowledge, and a genuine desire to improve our lot, will we ultimately make the right decisions and provide the good life for all.

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Contents

Chapter 1
Environment and Humans

Health is the avoidance of disease and injury and the promotion of happiness through efficient use of the environment, a properly functioning society, and an inner sense of well-being. Environmental health is the art and science of the protection of good health, the promotion of aesthetic values, and the prevention of disease and injury through the control of positive environmental factors and the reduction of potential hazards — physical, biological, and chemical.

To understand the relationship of the environment to humans and to understand how to protect humans from disease and injury, it will be necessary to discuss the ecosystem, ecosystem dynamics, and energy. Human impact on the environment and the various approaches used to resolve environmental problems, namely, epidemiologic, economic, legal, and governmental, will also be discussed. Finally, it will be necessary to understand the role of professional environmental health practitioners, the skills that they need, and how they work in the ever-growing field of environmental problems.

THE ECOSYSTEM

The earth is divided into the lithosphere, or land masses, and the hydrosphere, or the oceans, lakes, streams, and underground waters. The hydrosphere includes the entire aquatic environment. Our world, both lithosphere and hydrosphere, is shaped by varying life forms: Permanent forms of life create organic matter and help establish soil; plants cover the land and reduce the potential for soil erosion — the nature and rate of erosion affects the redistribution of materials on the surface of the earth. Organisms tie up vast quantities of certain chemicals, such as carbon and oxygen; plants and animals through respiration release carbon dioxide into the atmosphere — carbon dioxide affects the heat transmission of the atmosphere. Organisms affect the environment and in turn are affected by it.

Two environments, biotic (living environment or community) and abiotic (nonliving environment), combine to form an ecosystem. The ecosystem can also be subdivided by more specific criteria into the following four categories: abiotic, the nutrient minerals which are synthesized into living protoplasm; autotrophic, the producer organisms (largely the green plants), which assimilate the nutrient minerals using energy and combine them into living organic substances; heterotrophic, the consumers, usually the animals that ingest or eat organic matter and release energy; and the heterotrophic

reducers, bacteria or fungi, which return the complex organic compounds to their original abiotic state and release the remaining chemical energy. The biotic group in the ecosystem complex is essentially comprised of the autotrophs, or producer organisms that construct organic substances, and the heterotrophs, or consumer or reducer organisms that destroy organic substances. The ecosystem is important when considering the food chain, which is in effect a transfer of energy from plants through a series of organisms that eat and in turn are eaten. Eventually, decay will start the process all over again.

The ecological niche is the combination of function and habitat of each of the approximately 1.5 million species of animals and a half million species of plants on the earth. There are many interactions between species in the ecosystem, yet a balance is dictated by nature. The law of limiting factors states that a minimum quantity of essentials, such as nutrients, light, heat, moisture and space, must be available within the ecosystem for survival of the organisms. In some instances where these limiting factors apply or where pesticides or other environmental elements are introduced into the ecosystem, the organism alters itself in order to exist within the new environment. This change is called mutation. Unfortunately, mutation becomes a serious concern in the area of pest control as well as in disease, because a new organism may be highly resistant to effective control and may therefore cause disease, injury and physical destruction of plants and animals. The ecosystem is always in a dynamic, rather than static, balance. Changes in one part of the ecosystem will cause changes in another.

The Biosphere

The biosphere is that part of the earth in which life exists. However, this definition is not complete since spores may commonly be found in areas that are too dry, too cold, or too hot, to support organisms which metabolize. The biosphere contains the liquid water necessary for life; it receives an ample supply of energy from an external source, which is ultimately the sun; and within it liquid, solid, and gaseous states of matter interface. All of the actively metabolizing organisms operate within the biosphere. The operation of the biosphere depends on photosynthesis during which carbon dioxide is reduced to form organic compounds and molecular oxygen. Oxygen, the by-product of photosynthesis, replenishes the atmosphere and most of the free water, which contains dissolved oxygen.

Ecosystem Dynamics

The ecosystem changes frequently. Several of the cycles that are important and that may be affected by humans include the hydrologic cycle, the carbon cycle, the nitrogen cycle, the phosphorous cycle, and energy flow. The hydrologic cycle is the movement of water from the atmosphere to the earth and back into the atmosphere. This will be more fully discussed in the chapter on water.

The carbon cycle begins with the fixation of atmospheric carbon dioxide by means of photosynthesis performed by plants and certain microorganisms. During this process carbon dioxide and water react to form carbohydrates and free oxygen is simultaneously released into the atmosphere. Some of the carbohydrates are stored in the plant and the rest are consumed by the plant as a source of energy. Some of the carbon that has been

fixed by the plant is then consumed by animals who respire and release carbon dioxide. The plants and animals die, decomposed by action of microorganisms in the soil, and the carbon in their tissues is then oxidized to carbon dioxide and returned to the atmosphere. The carbon dioxide is recycled through the plants and the process repeats itself. Appropriate diagrams on the carbon cycle may be found in the chapter on sewage.

The nitrogen cycle begins when atmospheric nitrogen is fixed or changed into more complex nitrogen compounds by specialized organisms such as certain bacteria and blue-green algae. Some fixation may occur as a result of lightning, sunlight or chemical processes, however, the most efficient nitrogen fixation is carried out by biological mechanisms. Other bacteria, fungi, and algae may also play an important role in nitrogen fixation. Basically the atmospheric nitrogen is changed into a nitrate which is absorbed by plants, eventually becoming a plant protein. The plant protein may decay when the plant dies, change to ammonia, through bacterial action become a nitrite, and through further bacterial action be released as atmospheric nitrogen. The plant protein may also be eaten by animals and become an animal protein. Through decay of the dead animal or breakdown of feces and urine this protein is changed to ammonia. The ammonia returns to the nitrite stage through bacterial action and again through bacterial action becomes atmospheric nitrogen. A further description and diagram of the nitrogen cycle will be found in the chapter on sewage.

In the phosphorus cycle, the element moves rapidly through similar stages becoming locked in sediment or in biological forms such as teeth or bones. The primary sources of phosphorus for agriculture are phosphate rocks and living or dead organisms. Diagrams on the phosphorus cycle may be found in the chapter on sewage disposal.

Food Chain

The cycle of energy flow may also be described as the food web. The food web, or food chain, implies that an organism has consumed a smaller organism and is then consumed by a larger organism. Eventually, the microscopic plants and animals once the food supply for the small fish or animals become the food supply for humans. The importance of the food chain is illustrated by biomagnification, in which the impurities found in water are concentrated in the lower forms of life and are reconcentrated substantially during the movement of the impurities through the food chain. For example, whereas man might only get 0.001 micrograms of mercury in drinking water, he might get 30 to 50 micrograms of mercury by consuming fish that have been bioconcentrating mercury.

Energy Cycles

Solar energy is absorbed by the earth and is eventually reradiated into space as heat. The heat is distributed over the surface of the earth through circulation caused by the atmosphere and the oceans. Diurnal changes, or changes occurring in a twenty-four hour period due to wind, temperature, and humidity are important near ground level and at high levels in the atmosphere. In certain localities land masses and sea breezes may affect the overall heat and weather patterns. However, total heat movement is not affected significantly by local conditions.