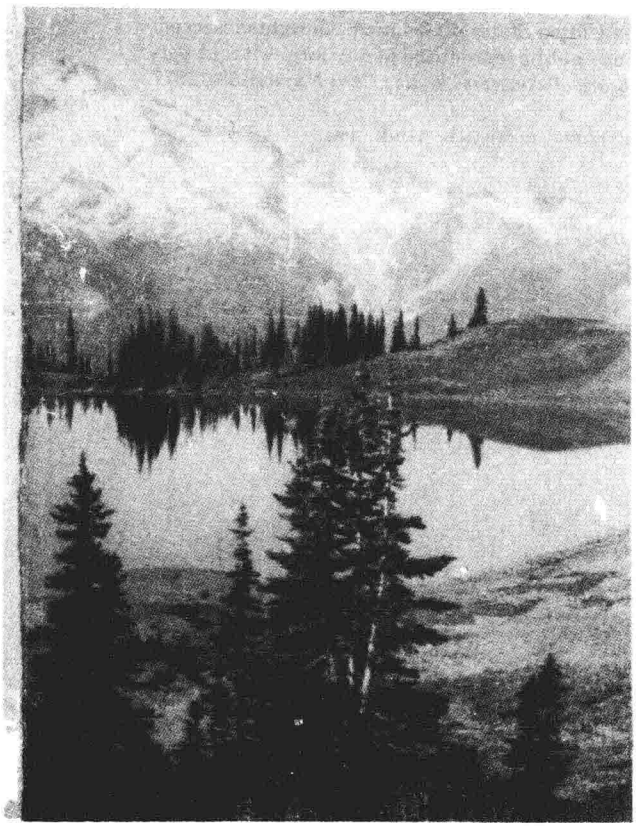
Natural Resources



Edited by

Martin R. Huberty

PROFESSOR OF
IRRIGATION AND ENGINEERING
DIRECTOR
WATER RESOURCES CENTER
UNIVERSITY OF CALIFORNIA
LOS ANGELES

and

Warren L. Flock

ASSOCIATE ENGINEER
AND LECTURER
UNIVERSITY OF CALIFORNIA
LOS ANGELES

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Natural Resources

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Martin R. Huberty
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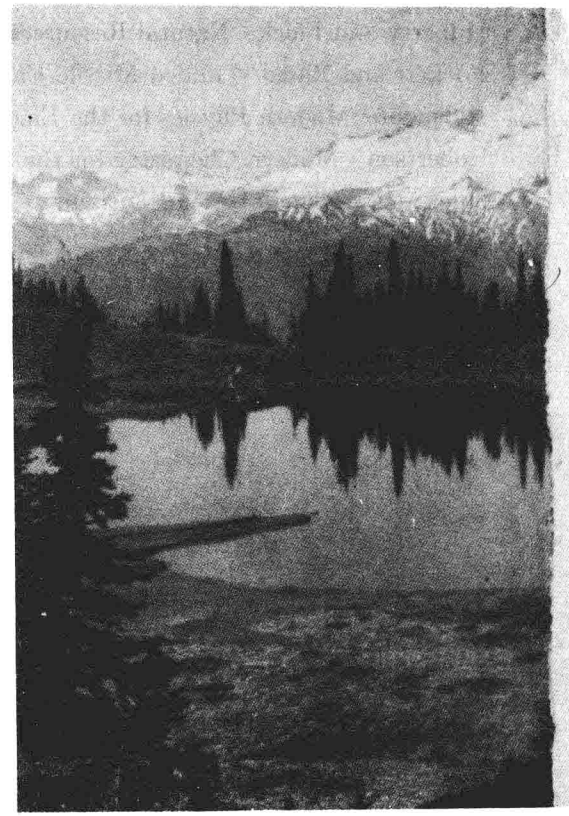

Glacier Peak from Image Lake,
Glacier Peak Wilderness, Washington.
(*Photograph by Philip Hyde.*)

The Authors

Varden Fuller, Professor of Agricultural Economics, University of California, Berkeley

Martin R. Huberty, Professor of Irrigation and Engineering, University of California, Los Angeles

Everett D. Howe, Professor of Mechanical Engineering, University of California, Berkeley

Milner B. Schaefer, Director of Investigations, Inter-American Tropical Tuna Commission, Scripps Institution of Oceanography, University of California, La Jolla

Roger Revelle, Director, Scripps Institution of Oceanography, University of California, La Jolla

Morris Neiburger, Professor of Meteorology, University of California, Los Angeles

Albert F. Bush, Associate Professor of Engineering, University of California, Los Angeles

Robert M. Glendinning, Professor of Geography, University of California, Los Angeles

Richard F. Logan, Associate Professor of Geography, University of California, Los Angeles

Hans Jenny, Professor of Soil Chemistry and Morphology, University of California, Berkeley

Arthur F. Pillsbury, Professor of Irrigation and Engineering, University of California, Los Angeles

F. W. Went, Director, Missouri Botanical Garden

Walter P. Taylor, Senior Biologist, Fish and Wildlife Service, U.S. Department of the Interior (Retired); Visiting Lecturer, Claremont Graduate School

John A. Zivnuska, Associate Professor of Forestry, University of California, Berkeley

Maynard A. Joslyn, Professor of Food Technology, University of California, Berkeley

Harold S. Olcott, Professor of Marine Food Technology, University of California, Berkeley

Donald Carlisle, Associate Professor of Geology, University of California, Los Angeles

Louis B. Slichter, Director, Institute of Geophysics, University of California, Los Angeles

Charles A. Scarlott, Manager, Technical Information Services, Stanford Research Institute

Frederick A. Brooks, Professor of Agricultural Engineering, University of California, Davis

Chauncey Starr, Vice President, North American Aviation, Inc.; General Manager, Atomics International Division

S. V. Ciriacy-Wantrup, Professor of Agricultural Economics, University of California, Berkeley

Joseph L. Fisher, Associate Director, Resources for the Future, Inc.

Foreword

Engineering achievement within a country is dependent to a large extent on the available resources of that country. As new resources are discovered and known resources are developed, a parallel refinement in technology may be observed.

Engineers and scientists must be continually aware of both natural and man-made resources, recognizing the impact on their community, state, and nation, as well as on their own specific areas of technical interest.

With this need in mind the departments of engineering at the University of California arranged a series of lectures in natural resources for the staffs, students, and graduates in industry in order to familiarize them with recent developments and thought in the subject. These invitational lectures were presented by distinguished scientists, prominent in their fields, from the University of California, other universities, and governmental organizations. The series was offered under the sponsorship of University Extension.

We are pleased to share the stimulating experience of the natural-resources lecture series with you, the reader, through the pages of this book.

PAUL H. SHEATS
Professor of Education
Director, University Extension
University of California
Los Angeles

L. M. K. BOELTER
Professor of Engineering
Dean, College of Engineering
University of California
Los Angeles

MORROUGH P. O'BRIEN
Professor of Engineering
Dean, College of Engineering
University of California
Berkeley

Preface

Natural Resources is an outgrowth of a lecture series given on the campus of the University of California, Los Angeles, by Engineering Extension in the fall of 1955. Chapters in this volume correspond to lectures in the series, although changes have taken place in the roster of persons making contributions.

The chapters are written by authorities in the field. All the major natural resources are considered. Yet in a subject as vast as natural resources, it cannot be claimed that all interesting or important aspects have been covered. A prominent feature is the consideration of technological developments and problems, including obtaining fresh water from saline sources, air pollution, geophysical exploration, solar energy, and nuclear energy.

The book is intended for the general public and for students in all fields as well as for those engaged in business or resource management, engineers, scientists, and educators.

Uses and potential uses for natural resources are increasing because of population growth, higher per-capita consumption, and the efforts of underdeveloped regions to achieve industrialization and higher standards of living. In addition, the present race for world military and scientific leadership applies extra demands upon resources. The potential needs are in many cases large with respect to known supplies. In view of the growing demands, the attitudes developed toward natural resources take on vital significance. The supplies and demands and the attitudes of men are discussed in the various chapters of this volume.

Much of the text is devoted to resources generally necessary for man's existence—water, air, soil, food, forests, minerals, and energy sources. Several chapters are given, however, to basic concepts and considerations. Chapters 1 and 20 deal with population, natural-resource consumption, attitudes toward natural resources, and natural-resource research themes. Chapter 19 treats of economics and policies of resource management. Chapter 10 describes the process of photosynthesis, while particular attention is given to wilderness in Chapter 11. Recreational resources,

and recreational aspects of resources, are discussed in several chapters. Human resources are considered, but a comprehensive treatment of this subject is beyond the scope of this volume.

Some other investigations of resources have been largely restricted to the question of meeting man's requirements for survival. Surely, however, quality of life is important, and those resources, and aspects of resources, which contribute to quality may be as important as those which merely make life in the modern world possible. As used here the term *quality of life* does not refer to being supplied in an ever-increasing degree of lavishness with entertainment, gadgets, or necessities, such as food, clothing, housing, and transportation. The term quality is used instead to indicate such things as desirable human relationships, freedom, knowledge, the arts, and with particular reference to natural resources, attractive, healthful, and inspiring surroundings. In this respect increasingly large numbers of people feel the need for maintaining sufficiently large and varied areas of natural beauty for inspiration and recreation. Such factors are given consideration in this treatment.

Energy is a key factor in resource considerations because of its wide and varied uses. Therefore energy is given a prominent role in this volume. Solutions of the world's material and food problems would be greatly facilitated by new, large sources of low-cost energy. Thus successful development of nuclear-fusion potentialities, for example, would be of great importance. It must be remembered, however, that the cost of energy is the crucial factor. The energy problem is not only one of technical availability but to a large extent one of economics. Furthermore, even with vast new sources of low-priced energy, all natural-resource problems would not be automatically solved. Space itself would be a prime consideration and might well be in short supply. Disposal of wastes may be a serious problem. Scenic and recreational areas are at present under strongly increasing pressures and may be entirely inadequate in the future unless vigorous measures are taken for their protection. Indeed there appears to be reason for being even more concerned about certain resources and aspects of resources which are primarily important to quality of life than for being concerned about the supply of energy, food, water, metals, or other materials. Some industries, as well as individuals, located in metropolitan areas have already come to realize that while they may not be immediately concerned about energy or material shortages they are very much beset by such factors as air pollution, congestion, lack of space for parking, air fields, and testing facilities, lack of pleasant surroundings, and lack of ready access to scenic and wild areas.

A confusing factor with relation to natural resources has been the apparent disparity between expressions of concern about resources and predictions of extremely high levels of prosperity with short-work weeks

and remarkable technological developments including wide applications of automation. Ordway* has discussed these matters and pointed out that the prosperity of the present and the immediate future provides time to obtain the solutions to resource problems. It might be added that the present world political and military situation is hardly conducive to thoughts of a leisurely, luxurious future. In addition, Ordway has raised questions concerning the desirability, for the present, of the devotion to growth which has in the past characterized much of the thinking of the nation. The latter topic is also discussed by Professor Fuller in this volume's initial chapter, which presents some of the most crucial considerations regarding natural resources, including the necessity for the assumption of responsibility by individuals.

No effort has been made to eliminate the inevitable differences in attitude and emphasis which can be detected among the contributors. It has been the intention in all cases, however, to present discussions which look forward to solutions to natural-resource problems.

The lecture series, on which this volume is based, and the preparation of the volume have been due to the direction and inspiration of Dean L. M. K. Boelter of the College of Engineering of the University of California, Los Angeles. The organization and presentation of the lecture series were coordinated by W. L. Flock, with the cooperation and advice of M. R. Huberty, the late S. T. Yuster, and the Engineering Extension staff, particularly J. C. Dillon, Head, R. R. O'Neill, and Mrs. Bernice Park. The editors wish to express their appreciation to the above persons for their part in the program and to the lecturers in the series, the authors of the chapters, and colleagues who have made helpful suggestions. They are also grateful to Mrs. Derfla Guthrie and Mrs. Marjorie Keller for secretarial assistance in the preparation of the manuscript.

Martin R. Huberty
Warren L. Flock

* Ordway, Samuel, *Prosperity Beyond Tomorrow*, The Ronald Press Company, New York, 1955.

Prologue

L. M. K. BOELTER

Natural resources are the bulwark of the nation. The range of resources and the quantities and location of resources at its disposal are measures of the nation's potential.

Engineering has been defined as "transforming the resources of nature for the benefit of mankind." Thus knowledge of the status and condition of resources is essential to the practice of engineering. The professional engineer should be familiar with the availability and consumption of resources, their cost, and the state of the art of beneficiation and transportation.

The utilization of resources is of earnest significance to every citizen as well as to the engineer. Every effort should be made to harbor our resources and at the same time to use them to yield significant positive influence on the economy. Great emphasis should be placed on the development of the use of renewable resources.

A new concept has been introduced in the measurement of the quantities of natural resources. Putnam (Palmer Putnam, *Energy in the Future*, Van Nostrand, 1953) has replaced the concept of use to extinction with use to a multiple of present cost. On the basis of such a concept, a second look at estimates of resources is here recommended.

Man has introduced synthetic materials, such as plastics, and has made available intermediate resources, such as transportation. Practically all these man-supplied resources rest on the bedrock of nonrenewable resources, such as the fossil fuels, and renewable resources, such as water. The designer utilizes either the original natural resources or a transformed state of those resources. A sound knowledge of natural resources has thus become of even greater importance.

Greater costs to the economy have been caused by human habits. Peoples from water-plentiful regions, for example, bring their water-profligate habits with them when they migrate to the desert. Another look at the resource picture, however, would suggest that strenuous efforts be made to accommodate to the new conditions.

The economy of the United States depends on bringing certain resources and products to groups of people in given locations and taking certain resources and products from these sites to other locations. The successful optimization of this complex transport problem will yield a rational and successful economic structure.

The greatest resource of all, man, is considered in this volume in a context which will allow conclusions on the shift of emphasis from man as a source of energy to perform tasks to man as a thinker, a planner, and a source of control. It is hoped that the volume will prove stimulating to the reader and that it will generate thought and action.

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Contents

1

Natural and Human Resources

VARDEN FULLER

PROFESSOR OF AGRICULTURAL ECONOMICS
UNIVERSITY OF CALIFORNIA, BERKELEY

1.1 Perspective

Civilized man is simultaneously a consumer of resources, a producer of resources, a manager of the yield and stock of resources, and himself a productive resource. He is both creator and creature of his culture. Over the centuries, thoughtful men have striven to discover a "law" or a general principle that would explain the complexly multisided relation between man and his physical universe. To make such inquiries at all manageable, it is convenient if not actually necessary to approach the inquiry from one or the other of two alternative perspectives: assume that man is the producer, the active agent, the determiner; or assume that man is the product, the creature, the determined. From the latter perspective, the search becomes that of a natural law or a biotic or ecological principle that explains man's numbers and his welfare condition. From the perspective that man is the producer and, hence, the determiner of his numbers and his state of welfare, the search becomes that of a concept of an optimum population and the identification of the forces and influences that could be expected to produce it.

In spite of their great efforts, neither the searchers for a natural law nor those seeking a concept of a controllable optimum have succeeded. The ingenuity of man's intellect defies his being analyzed as the counterpart of the lower-life biotic forms. Yet, on the other hand, man's ingenuity has not sufficiently developed to give him more than a partial, and at that possibly only temporary, dominance over the forces and endowments of his physical world. So long as the fabric of civilized life is woven of some strands that man determines and of others that are determined for him, it would appear unlikely that the search for an all-inclusive explanation of population-resource relations is soon to be rewarded.

For the purpose of this chapter, it is assumed that the foremost concern is whether man is overusing the endowments of his habitable world. "Overuse" in the sense here employed implies nothing more than that the current and prospective rate of population growth combined with the current and prospective rate of improvement in the standard of living may not be sustainable. If all societies of the world understood and were able to accommodate to the prospect that, at some stage, either the numbers of people or the standard of living might have to be reduced, then rapid current use would not be *overuse* in the sense indicated above. But if human beings individually and collectively do not have the capacity to accommodate themselves realistically to such a prospect or persist in assuming that its burdens can be passed to some other part of the world, then any current rate of population growth or rate of improvement in the standard of living that is not sustainable involves an overuse of resources.

If the relation of man to his resources were a direct biotic one, it would seem possible to detect present or approaching overuse of resources. However, for modern-day man, such a detection is difficult or impossible because of the intricacies of the political, economic, and technological systems through which he approaches resource utilization. Rapid depletion of a national stock of mineral or petroleum may not actually be overuse if there is assurance of international trade; but reversion from international trade to a system of closed national economies may change the situation completely and clearly reveal an unwise overuse. Similarly, unrewarded confidence in the prospect of technological advance may ultimately reveal that rapid depletion of nonrenewable stocks was actually an irrational overuse.

The complexity of the economic-political-technological systems through which modern man approaches resource use involves a number of paradoxes. In undeveloped countries where a low rate of resource exploitation usually prevails, economic development (and accelerated resource use) may be obstructed by actual or latent high rates of population growth which prevent the accumulation of capital. Conversely, in the advanced industrial economies, maintenance of high rates of growth (and of resource use) may depend heavily upon high rates of population growth. Thus, to facilitate the initiation of economic development, the undeveloped country needs to restrain population growth; to guarantee its further development, the already developed country may need to encourage population growth.

Unadvanced countries are more than ever committed to improvement and economic development. Advanced countries are committed to a philosophy of progress, prosperity, and full employment. Can the goals of all countries be simultaneously attained? Whether they can depends

first of all on the extent to which free world trade as against economic nationalism prevails. Intermediately, there is the question of whether the rates of population growth will be appropriate to each type of situation; and, ultimately, there is the question of the sufficiency of the world's stock of nonrenewable resources and of man's technological ability to manipulate their use. In the past, the totality of the world's resources has probably never been more than a very remote question. But today it is much more immediate. The maintenance of progress and prosperity in industrially advanced countries requires a prodigious and accelerating consumption of resources and raw materials, including such critical ones as metals and fuels. As the less-developed countries become more advanced, they similarly will have mounting resource and raw-material needs. Given the prospects that now exist in the world, the likelihood of critical situations in the world's stock of resources is hardly debatable; the only real uncertainty is the timetable.

Modern studies in the field of population-resource relations commenced in controversy and with a name—Malthus—that has popularly become a synonym of pessimism and dismay. In this tradition, and unfortunately, discussions of population-resource relations are likely to be exercises in controversy in which the participants usually feel obligated to declare themselves as to whether they are pessimists or optimists, Malthusians or anti-Malthusians. In a similar way, the bulk of the current publications in this field tend toward extremes of position and toward shrill argumentation. Implicitly if not explicitly, writers are impelled to prove something, and most often it is whether Malthus was right or wrong.

The propensities to preconception and to the taking of positions are unquestionably obstructive to clear thinking and to orderly development of knowledge. One often hears reference to the race between population and food supply. If, by more thorough mastery and exploitation of his universe, man is able to subsist ever larger populations, is he then triumphant? Surely the substance of civilization is more profound and fundamental. If man is in any sort of race with the endowments of his physical world, attaining the maximum population that can survive seems hardly a goal worth trying to win. And even if the goal is optimum level of living rather than maximum numbers, the conception of a race is still inappropriate for it is doubtful if the optimum quality of life is to be attained by the maximum consumption of physical goods. Surely the societies of advancing economies will reach a point where woods and streams will be preferred to more superhighways, and where additional leisure time will contribute more than the latest model household appliances or ever more powerful automobiles.

Notwithstanding whatever there may be of argumentation for the sake of the argument and of shrillness for the sake of egocentric satisfac-