

FOOD, CLIMATE, AND MAN

Edited by Margaret R. Biswas & Asit K. Biswas

With an Introduction by Mostafa Kamal Tolba

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To Elmore Jackson
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SERIES PREFACE

Environmental Science and Technology

The Environmental Science and Technology Series of Monographs, Textbooks, and Advances is devoted to the study of the quality of the environment and to the technology of its conservation. Environmental science therefore relates to the chemical, physical, and biological changes in the environment through contamination or modification, to the physical nature and biological behavior of air, water, soil, food, and waste as they are affected by man's agricultural, industrial, and social activities, and to the application of science and technology to the control and improvement of environmental quality.

The deterioration of environmental quality, which began when man first collected into villages and utilized fire, has existed as a serious problem under the ever-increasing impacts of exponentially increasing population and of industrializing society. Environmental contamination of air, water, soil, and food has become a threat to the continued existence of many plant and animal communities of the ecosystem and may ultimately threaten the very survival of the human race.

It seems clear that if we are to preserve for future generations some semblance of the biological order of the world of the past and hope to improve on the deteriorating standards of urban public health, environmental science and technology must quickly come to play a dominant role in designing our social and industrial structure for tomorrow. Scientifically rigorous criteria of environmental quality must be developed. Based in part on these criteria, realistic standards must be established and our technological progress must be tailored to meet them. It is obvious that civilization will continue to require increasing amounts of fuel, transportation, industrial chemicals, fertilizers, pesticides, and countless other products; and that it will continue to produce waste products of all

x *Series Preface*

descriptions. What is urgently needed is a total systems approach to modern civilization through which the pooled talents of scientists and engineers, in cooperation with social scientists and the medical profession, can be focused on the development of order and equilibrium in the presently disparate segments of the human environment. Most of the skills and tools that are needed are already in existence. We surely have a right to hope a technology that has created such manifold environmental problems is also capable of solving them. It is our hope that this Series in Environmental Sciences and Technology will not only serve to make this challenge more explicit to the established professionals, but that it also will help to stimulate the student toward the career opportunities in this vital area.

Robert L. Metcalf
James N. Pitts, Jr.
Werner Stumm

FOREWORD

I believe that the fundamental question that confronts mankind at present is how to meet the basic human needs without simultaneously destroying the resource base—that is, the environment—from which those needs must be met. Hence an understanding of the interrelationship between environment and development is absolutely essential to any strategy for the protection and improvement of the environment. This is the process I have often termed *development without destruction*, and in a book entitled *Food, Climate, and Man*, it is desirable to discuss this important concept.

Many of the negative aspects of development have so impressed themselves on the minds of those concerned with the environment that the question has often been asked, “Why development?” Some have even advocated arresting economic growth in the interest of promoting environmental protection.

It is true that, in the past, industrial and agricultural development have created such environmental problems as water, soil, and air pollution, with consequent costs to human health and well-being, spread of the deserts through the mismanagement by man of natural ecosystems, and so on. Such problems are seldom localized and, through their interactions with other factors, frequently become matters of regional or global concern. What, for instance, is the possible impact on global climate of the continued combustion of fossil fuels to meet energy demands? There is no doubt that there are “outer limits” to the ability of the biosphere to absorb the impact of man’s activities, and such limits must be respected for man’s own long-term well-being, even for his own ultimate survival.

It should also be realized that the environmental problems are caused by a lack of adequate development. Today there are hundreds of millions of people without the basic human necessities like adequate food, shelter, clothing, and health; hundreds of millions more lack access to even a rudimentary education or regular employment. This is not only an intoler-

able situation in human terms, but it also has serious environmental consequences. The relentless pressures that arise when basic human needs are not met can reduce the resource base from which man must inevitably gain his sustenance. The destruction of forests, the loss of arable soil, the loss of productivity through disease and malnutrition, and the increasing pressure on fragile ecosystems that so often result from poverty—these things are as significant as the pollution created by industry, technology, and overconsumption by the affluent. All of them lead to the rapid depletion of basic natural resources, as is discussed by Margaret Biswas elsewhere in this book.

With these thoughts in mind, I would say three things in commenting on the question “Why development?” First, for the developing countries of the world, in which more than two thirds of mankind live, there is no alternative to pursuing economic and social change so as to meet the basic human needs and secure better prospects for their citizens. What is more, the lesson of the United Nations Conference on Population, held at Bucharest in 1974, is that only when the poor in the world have a more satisfactory existence will the rate of population growth—itsself a major contributory factor in environmental problems—begin to slow down. Next, it has often been noticed that the manner in which development takes place is too often destructive to the environment, and the basis for continued development is thereby threatened. The third point is that, far from being in conflict, environmental and developmental objectives are complementary and should be viewed as two sides of the same coin.

This last point needs a little elaboration. A few years ago, the environmental problem was thought of solely in terms of pollution, whereas economic and social development were measured solely in terms of growth in gross national product. Given these premises, the pursuit of environmental objectives through pollution control was seen as a check on development. But there have been significant advances in recent years in our understanding of what is meant by environmental and developmental objectives, and there is a growing acceptance that these converge. We should look on environment as the stock of physical or social resources available at a given time for the satisfaction of human needs and on development as a process pursued by all societies with the aim of increasing human well-being. Thus the ultimate purpose of both environmental and development policies is the enhancement of the quality of life, beginning with the satisfaction of the basic human needs. We should therefore not query whether to develop; we should establish a new kind of development related not only to the opportunities offered by the natural resource base but to the limitations imposed by that base on various activities. It is now clear that the past patterns of development in both

developed and developing countries have been characterized by such serious environmental damage that they are simply not sustainable on a long-term basis.

What are the features of this new kind of development? I believe that there are three that are particularly relevant: it is needed by all countries, rich and poor; it presupposes new directions for growth and development, not their cessation; and it incorporates the environmental dimension.

There are, however, certain important differences between the form and the new kind of development might take in industrialized countries and that which would emerge in developing countries. In the industrialized countries, it will be necessary to reorient society's aims so that the entire population will have more opportunity for self-expression in the fields of culture, education, the arts and humanities—those nonphysical areas of development that represent the highest levels of human achievement. This new orientation must be less demanding on the environment, particularly on natural resources and energy. Present patterns of production and consumption, based on waste, extravagance, and planned obsolescence, must be replaced by conservation and reuse of resources. I am encouraged by signs from several industrialized countries that such a reorientation of life-styles and societal aims are now being discussed seriously, though clearly the change implied by this approach is immense and will take many years to carry through.

In the developing world, which still lacks the infrastructure and readily useable resources required to meet the growing needs and aspirations of its peoples, the new kind of development must continue to have a strong physical orientation. But each country should be helped to follow a path to development that is best suited to its own human skills and natural resources and responds to its own needs and accords with its own culture and value systems. Developing countries should have access to the technologies they require and should be enabled to adapt these technologies to their own needs, rather than have their development processes distorted by the dictates of imported technologies. Most of all, the new forms of development in the developing world should be based on practices environmentally sound in relation to each country's natural resources of soil, water, and plant and animal life, with care taken to avoid the destruction of the resource base.

The new kind of development should avoid the irrational and wasteful use of resources. Development is irrational if resources are not used in the best known ways to further the aims that a given society has set for itself and account is not taken of all effects known to follow from such action. It is also irrational to waste resources by using more of them than necessary for a given purpose. I will illustrate this theme by one or two examples.

Effluents from industry are commonly regarded as threatening to human health and well-being. It has been remarked that a pollutant is a resource in the wrong place, and certainly the well-known example of sulphur, which can be retrieved from factory chimneys and used for industrial purposes, is a case in point. I do not think it rational to lose more and more resources as pollutants and then to use other resources in even greater quantity to offset the effects of that pollution.

Another example: It has already been demonstrated that resources, like wildlife, if wisely used, can provide food in a manner less destructive to the soils and vegetation of the area than the "traditional" pastorage of cattle and that, through tourism, wild animals can bring to a country valuable foreign exchange. Yet, despite the efforts of governments, this resource is being steadily destroyed the world over for short-term profit—used, that is, irrationally and wastefully.

These new approaches to development also have international implications. The debate around the New International Economic Order, with its emphasis on meeting basic human needs, making fairer use of the world's natural resources, and meeting the need for development in a form appropriate to each country's requirements, shows that there is already some sense of these implications. I hope that the international community, especially the developing nations, in advocating and designing the much-needed new economic order, will not forget that there will be no sustained development or meaningful growth without a clear commitment at the same time to preserve the environment and promote the rational use of natural resources.

I have tried to clarify what I mean by *development without destruction*. I mean sustained development, which takes due regard of environmental constraints. Nowhere is that need more in evidence than in the provision of food, an important theme of this book.

There has been mounting concern in recent years about food, the world's number one problem. We in UNEP share this concern, and feel deeply about the necessity of moving toward solutions that maximize food production yet do so without destroying the ecological basis for sustaining such production.

Any strategy to increase food production on a sustained basis should take explicit account of the complementarity of environment and development. The urgency and magnitude of the task of more than doubling food production by the end of the century and at the same time assuring the supply of basic food requirements to all should not be underestimated. It is vitally important that the measures taken to increase food production on a short-term basis be sustained and effectively integrated with long-term policies. To achieve this, the following considerations, many of which are discussed in greater detail in this book, need to be borne in mind.

One, pressure to expand areas under agriculture—frequently aggravated by the loss of good agricultural land and by industrial and human settlements requirements—has often resulted in serious environmental disruption. To cite but a few examples, the expansion of agriculture to steep hillsides has led to serious erosion in Indonesia; increasing pressure of slash-and-burn agriculture has adversely affected tropical forests in the Philippines; deforestation in the Himalayas has contributed to the increasing frequency and severity of flooding in Pakistan, India, and Bangladesh; and overgrazing and deforestation has assisted the southward march of the Sahara in the Sahelian Zone of Africa. Experts estimate that the land being lost to agriculture by such processes may now exceed the acreage of new land brought into production. Thus rational management of arable and pastoral agricultural land is becoming an increasingly urgent need.

Two, technology transfers in the field of agriculture have often not taken root because proper account was not taken of local, cultural, economic, and ecological conditions. Equally dismal has been man's frequent inability to use locally available technology. For instance, simple, inexpensive countermeasures known over centuries, like terracing to prevent soil erosion, are often ignored. Existing technical and scientific knowledge must be better mobilized and more effectively applied to ensure sustained rather than short-term benefits.

Three, there is an intimate relationship between inputs of energy and output of food. Scientifically planned inputs of energy to the land can yield extraordinarily favorable results, though a saturation point can be reached where any extra inputs are wasted, and serious environmental degradation may result. Large amounts of the energy spent on producing packaging materials like paper and plastics and on transport, storage, marketing, and the like could be conserved so that the energy is available to apply on the land.

Four, fertilizers are indispensable for increasing food production, but their excessive use has occasioned much concern as a possible environmental threat. Production and environmental aims require that fertilizers be used with maximum efficiency on the farm, but it is never efficient to create dangers for man or his environment. New types of nitrogen fertilizers must be developed that release their nitrogen as nitrate into the soil solution during the growing season at a rate comparable to the crop demand for nitrates; biological sources of fertilizers, especially microbiological nitrogen fixation and compost, need to be further developed and applied.

Five, pests cause significant losses of crops throughout the world despite continued and ever increasing use of pesticides. This has resulted, through the processes of natural selection and evolution, in the appearance and proliferation of new strains of pests that may be more vicious

and less susceptible to control by chemicals. Neither larger doses nor the use of different pesticides provides a permanent solution. Another major problem is that existing modes of applying chemical pesticides have extremely low efficiency rates. Several studies indicate that a very high proportion of pesticides applied by aircraft never reaches the target and creates totally unnecessary ecological hazards. A third element of concern is that the distribution of pesticides through ecosystems takes place most commonly by selective concentration as the pesticides pass through successive levels of food chains and food webs; thus high pesticide levels accumulate in the higher animals and in man. It is therefore essential to develop effective new methods of integrated pest management, incorporating an ecological approach to pest control; where the use of pesticides cannot be avoided, the efficiency of their application should be increased. The motto should be "efficient use of pesticides: more on target, less outside."

Six, vast losses of food stocks occur each year during storage, processing, and handling. According to some estimates, rodents eat or destroy an amount sufficient to feed nearly 200 million people. Federal authorities estimate the cost to the United States economy of losses due to rats at well over one billion dollars per year. In Africa, almost 30% of all crops are lost in storage. Thus new and better techniques to conserve food by preventing loss and waste could play a major part in improving the world food situation.

Seven, weather and climate have always been important to crop production, often outweighing the factors subject to human management. Today there are increasing signs of possible changes in climate and weather patterns. Man's ability to predict and to anticipate these changes has greatly improved, and he may soon develop a new capacity to influence them as well. Improved long-term forecasting is needed to make crop planning more efficient. There is also an urgent need to develop mathematical models to explain how climate and agriculture interrelate.

Eight, irrigation schemes are undoubtedly needed in the developing countries, but after several years salinization of the soil may render it once again unproductive. In some cases, moreover, they result in the spread of waterborne diseases. The application of ecological and environmental principles, beginning at the planning stage, would avert these hazards and improve the health, well-being, and productive capacity of the population.

Nine, we know that the world can produce a surplus of food and that much more can be produced where the skills and capital are available. The international community must develop mechanisms to distribute surpluses from the favored regions so as to prevent or remedy the unjustifiable coexistence of overconsumption and starvation.

Ten, strategies to solve the world food problem must be developed in full knowledge of the web of interdependence that exists between this and the other major problems facing mankind—those of population, energy and other raw material shortages, underdevelopment, and environmental degradation.

I have stressed the food issue because it is not only the central theme of this book, but it also illustrates so well the importance of assessing the environmental impact of various forms of development and the necessity of adopting an environmental approach to the management of activities within the development process generally.

In the years ahead, we face the task of meeting the minimum human needs of mankind and of avoiding environmental catastrophes. I have spoken encouragingly about the prospects, because I am convinced that disaster is not inevitable. But the urgency is extreme; we have very little time in which to set right our approach to the environment and to meet the legitimate demands of the world's poor. We shall need to act far more thoroughly and speedily than hitherto to redress environmental and human grievances, and we shall need to harness the energies of all sectors of society in the effort. No sector has a more important role than the scientific community. It is the duty of science to bring the problems and solutions to light to display them with appropriate objectivity. Through the diligence and thoroughness that is the mark of all sound scientific endeavor, scientists can help man to see dangers that confront him, and to understand that it is essential that he adopt wiser and safer approaches to managing his planet.

For the above and other reasons, I consider *Food, Climate, and Man* a very timely and important book. Edited and written by nine of the world's leading scientists, the book provides up-to-date information and thinking about the interrelationships between food, climate, and man. As the Executive Director of UNEP, it gives me great pleasure to note the close connection between the editors and most of the contributors and UNEP. I am further gratified to note, as the editors have pointed out in their preface, that the idea of this book originated at the World Food Conference, which both of them attended on behalf of UNEP under my leadership. I am convinced that this book will be read widely and will be a major contribution to our understanding of food and climate, as they relate to man. I wish the book every success.

MOSTAFA KAMAL TOLBA
Executive Director
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PREFACE

And he gave it for his opinion, that whoever could make two ears of corn or two blades of grass to grow upon a spot of ground where only one grew before, would deserve better of mankind, and do more essential service to his country, than the whole race of politicians put together. —JONATHAN SWIFT, 1667–1745

Food crisis is undoubtedly one of the major crises facing mankind at present. With increasing population, and rising affluence of certain segments of that population, the world demand for food has been steadily increasing in the past. Unfortunately, however, in the "Poverty Belt" of Asia, Africa, and Latin America—where most of mankind lives—malnutrition is a chronic problem, and the number of people suffering from malnutrition has also been steadily increasing in recent years.

Food problems of the world cannot be solved in isolation—without consideration of their interrelationships with other important problems facing mankind today, such as those of population changes, economic development, availability of adequate energy and raw materials, development of new technology, high inflation rates, and shortage of investment capital. All these factors have significant impact on food production, some beneficial and some adverse, and food production, in its turn, affects development in those areas.

In addition, there are the problems of forecasting future political and technological developments and the difficulty, often near impossibility, of predicting the secondary and tertiary effects precipitated by these developments. For example, few scientists predicted the effectiveness of the oil boycott, and even fewer foresaw its effects on the price and availability of fertilizers and the resulting food shortages in many parts of the world. The process is further complicated by the fact that there is generally a time lag between an action and the development of secondary effects, and the side effects of a proposed action are seldom totally anticipated at the time action is taken. It is not exactly unusual to find that the combined effects of the secondary developments could even be worse than the

original wrong the action was intended to correct, as discussed elsewhere in this book. Thus it is important to realize the necessity of long-term planning, because during the present era of rapid social, economic, political, technological, and institutional changes, short-term forecasts are likely to be very deceptive and could even be diametrically opposite to the long-term development goals of mankind.

Even though many aspects of the problems considered in this book are interdependent and global in nature, in their magnitude they vary widely from region to region, and even from one part of a country to another. For example, some parts of the world may be more concerned with excessive protein intake and problems of obesity, whereas other parts suffer badly from a lack of protein and the resulting malnutrition and diseases. Thus two of the most important factors to consider in any analysis of global problems are the diversity of circumstances and the vastly differing magnitude of problems to be found around the world. In addition, we must remember that the nation state is, and will continue to be, the central repository of power and has the primary responsibility for the action that must be taken to deal with these complex issues. International cooperation is necessary to establish the global frameworks required, but if the action taken by nations is to be effective, only the exercise of national sovereignty and acceptance of national responsibility can provide the basis for such action. Naturally, the action taken will reflect the nation's relative priorities as well as the complex interaction of each society's own social, economic, cultural, political, institutional, and religious motivations and goals.

All of these major issues form a complex system of cause-and-effect relationships in which the dynamics of our future will be shaped. They increase by many orders of magnitude both the potential for conflict and the need for cooperation. It is in their interaction, not in any one of them, that the future of mankind will be decided. Increase in population and provision of basic human necessities to each individual mean more food, energy, and raw materials; intensifying the supply of food means more land, water, energy, and fertilizers; the energy crisis and higher oil prices mean less energy available to increase food production and to alleviate fertilizer shortages; and the common denominator in virtually all responses to these problems must include more capital, more technology, and more cooperation. It is here that these concerns inevitably merge with the important issues of war and peace and monetary and trade relations. Each affects and is affected by the others. This system of relationships is global in scale. That is not to say that all global problems can be met with global solutions; there are few global solutions. But they can only be

understood and dealt with in a global framework, within which there can be a wide variety of national and regional responses.

The major problems we are now facing, including that of food, are urgent and complex, and if appropriate action is not taken immediately, they are bound to proliferate, making conditions even worse. Since these problems are often multidimensional, no nation, however powerful, can cope with them individually and unilaterally. Many problems go far beyond the capacity of even small groups of the more powerful nations to solve. Action taken to combat these types of problems must be well planned and coordinated, otherwise, steps taken to alleviate the problems in one part of the globe could create negative reverberations in another. The so-called "food crisis," "energy crisis," and "raw materials crisis" dramatize the finiteness of our earth, a sober reality that should be accommodated within the context of social, economic, political, and institutional frameworks.

Faced with these serious problems, a series of major world gatherings has been held under the auspices of the United Nations, which have attempted to develop workable "Action Plans" for the resolution of the problems. Among these are the Conference on the Human Environment at Stockholm (1972), Special Session of the General Assembly on Raw Materials and Development (1974), Law of the Sea Conference at Caracas (1974), World Population Conference at Bucharest (1974), World Food Conference in Rome (1974), the Special Session of the General Assembly on Development and International Cooperation (1975), Conference on Human Settlements at Vancouver (1976), World Water Conference at Mar del Plata (1977), World Desertification Conference Nairobi (1977), and Conference on Technical Cooperation Between Developing Countries at Buenos Aires (1978). All of these conferences deal with particular aspects of the complex issues affecting man and his quality of life on this earth.

The idea of this book originated when both of us were at the World Food Conference in Rome, with Dr. Mostafa Kamal Tolba, Executive Director of the United Nations Environment Programme for that organization. We developed the framework and invited leading international authorities to write specific chapters. The need for such a multidisciplinary book was immediately obvious, since all the contributors we approached, very busy as they were, readily agreed to prepare the chapters—a most unusual phenomenon under the best of circumstances. Furthermore, Dr. Tolba, despite his many commitments, both as the Executive Director of UNEP and the Secretary-General of the UN Conference on Desertification, consented to write an introduction for the