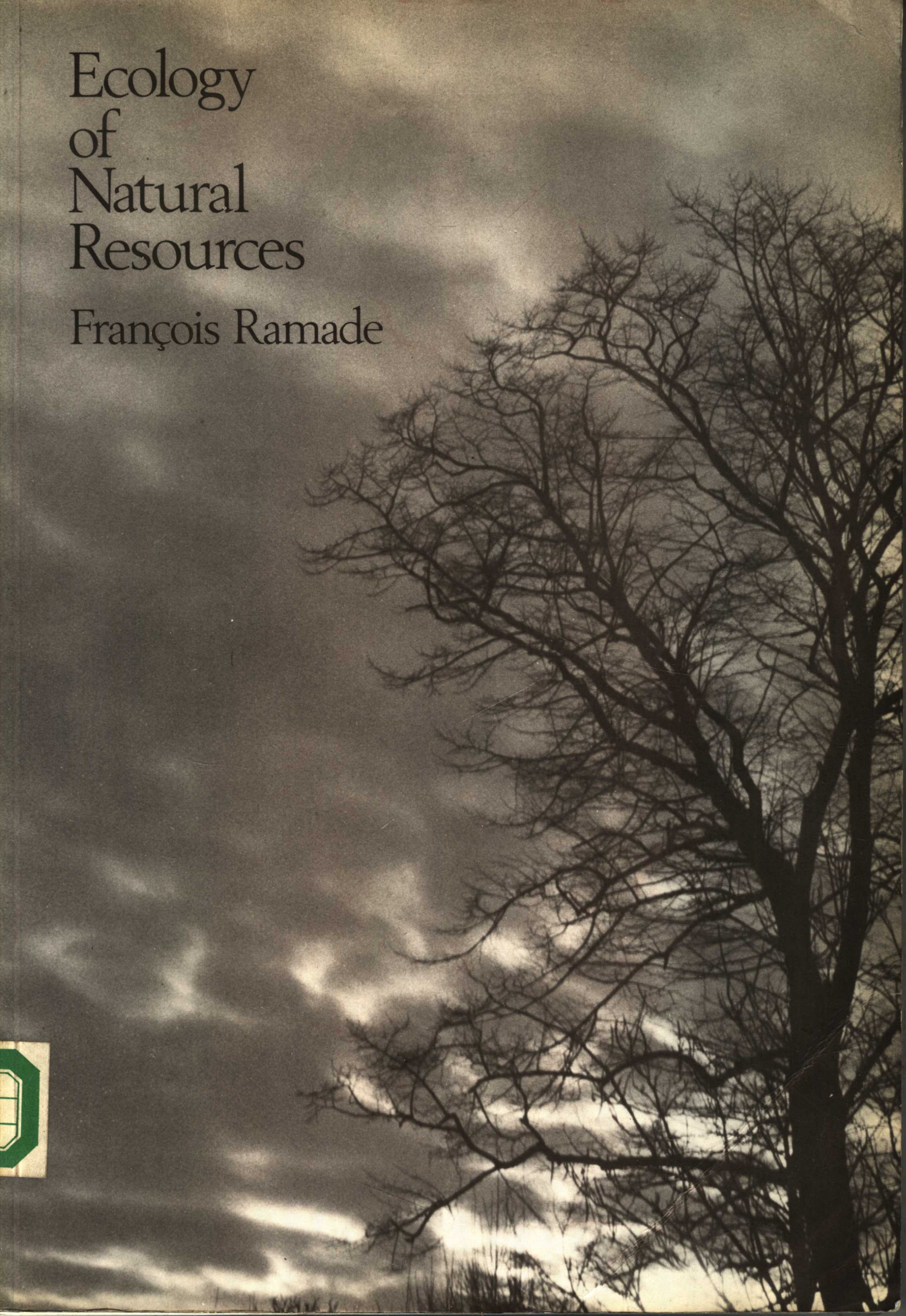
Ecology of Natural Resources

François Ramade



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Foreword

Reader, do you remember how, barely 10 years ago, futurologists and economic prophets were announcing to us all in a blaze of publicity that the major problem of tomorrow's citizens would be the occupation of their leisure time? And how the few pioneers in ecology who put forward quantitative evidence opposing this anaesthetizing myth were met with nothing but a disdainful silence from traditionalists on all sides?

Now the wind has changed. Shifts in the balance of world power and the resultant redrawing of the geopolitical map, the energy 'crisis' and upheavals in the Third World have put an end to the complacence of many of those holding the above opinion. We have passed from a smug optimism to a chronic pessimism, trying hard to ignore the future for the better enjoyment of the present. Après nous la fin du monde!

Such an attitude is just as irresponsible as the previous one, and this new book of François Ramade clearly demonstrates that, while the situation is serious, it is certainly not desperate—as long as we are willing to look beyond the end of our noses and draw the necessary conclusions in time. There *are* solutions to our problems but they must be willingly adopted or they will be violently imposed from outside. If the necessary measures are not taken in time, 'the Third World will only be able to advance by shattering the world's social order in one way or another' (Fernand Braudel, *Civilisation matérielle, économie et capitalisme*, Vol. 3, 1979, p. 469). At best, this would bring about a progressive collapse and decline of the civilization of which we are so proud; at worst, it would provoke a great march northward of the starving, and the dawn of the new Middle Ages.

What are these measures that seem forced on us by the inescapable laws of physics and biology?

First of all, it is more than ever necessary to put an end to the world's population explosion. Particularly urgent is the need to think at once about reducing the pressure in already overpopulated regions by freely accepted birth control: a measure that will undoubtedly require a colossal effort of education.

In parallel with that, the enormous wastage of renewable resources indulged in so freely by the West's consumer society should be reduced as far as is humanly possible and, at the same time, everything that can be recycled should be recycled.

The third, equally urgent, measure is the conservation of the potential biological productivity of land, sea and inland waters, and its rehabilitation in those environments where fertility has been thoughtlessly reduced through activities working against nature. This action must be accompanied by the preservation of the world's genetic stock of plants and animals, the fruit of hundreds of millions of years of evolution.

The final objective—and by no means the easiest to attain—is the need to learn how to share the available resources so as to reduce the most glaring inequalities between the 'haves' and the 'have nots'. Alas, no political movement of any importance dares for one moment to face this problem, because its solution necessarily implies some reduction in the standard of living of the present most wealthy countries.

It is greatly to be feared, therefore, that the inevitable unpopularity of many of the measures needed for an immediate response to the four requirements I have just outlined means that the necessary decisions will be taken too late and under the pressure of a 'crisis' that will have become endemic.

Moreover, things are not made any easier by the obsession of too many Third World leaders with a blind copying of models of development which were valid in other places and at other times, but which are ill-adapted to their current situation. Nor does the moral abdication on the part of too many 'elites' in wealthy countries help in any way. At a time when egocentricity, hedonism and laxity seem to have become the three Western pillars of wisdom, how can we hope to arouse in ourselves the great effort of imagination and research, the altruistic spirit and the sheer crusading attitude needed to take rapid decisions?

I hope that the pages which follow will nevertheless cause many future leaders of our society to reflect on such matters, and help to give their lives a new sense of direction. For all those who are not satisfied with the dullness of daily existence, there are as many exhilarating tasks to be undertaken today as there were yesterday. Knowing how to respond quickly and efficiently to the appeals of thousands of millions of the underprivileged presents a challenge that we must have the courage to accept as soon as possible.

François Bourlière,
Honorary President of the International Union for the Conservation of Nature; President of the Société Nouvelle de Protection de la Nature and of the International Association for Ecology (INTECOL)

Acknowledgements

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I should also like to express my sincere thanks to my friends and colleagues, Y. Gillon, J. C. Moreteau and F. Terrasson, who have contributed to the illustration of this book by allowing me to use certain photographs from their personal collections.

Introduction

Like all other living beings, humans require matter and energy. It is not being too sceptical about possible advances in science and technology to say that our species could obviously not set itself free from such requirements, whatever future progress might be envisaged.

Human beings are animals and are therefore heterotrophic organisms.[1] As such, their metabolic requirements are met by the air they breathe and by the water and organically derived food they ingest. Like other living species, they depend on the cosmic system from which they have descended: essentially the sun together with the ecosphere, the superficial part of our planet where the environmental conditions exist that make life possible.

However, continual advances in technology have caused other needs to appear in addition to those resulting from natural biological processes. The development of an ever more complex industrialized society in which the production of manufactured objects is incessantly growing entails a continually increasing use of primary energy and of organic and inorganic raw materials.

Just as metabolic processes involve the discharge of mineral and organic excreta, so the activities of a technological civilization release waste products into the environment. In both cases, the discharged material does not simply disappear from the environment that receives it: instead, it circulates in biological systems which can cease to function properly if their homeostatic mechanisms are overstretched.

Another feature of the contemporary world that arises from human activity and has a considerable impact on the ecosphere is the explosive growth in population. This, along with the unending increase in *per capita* consumption of manufactured goods, puts great pressure on nature and natural resources.

This takes us a long way from one of the fundamental concepts of industrial civilization, that of *Homo ecônomicus*, which regards humanity as the owner of all mineral and biological resources and thinks of these resources as inexhaustible and to be disposed of as we please. According to this idea, humanity is extraneous to the ecosphere and thus independent of any ecological changes in it that might be produced by human activity.

The very concept of a natural resource is worth some reflection. A resource can be defined simply as any form of energy or matter necessary to satisfy the physiological needs of humanity or to sustain all the various activities leading to production. The flow patterns of such resources through human civilization are very complex and so can be studied from several different angles.

Between the stage at which the resource is extracted and that of its use by a consumer, it undergoes many transformations, and these often have an impact on the overall functioning of the ecosystems in which the processes occur. A classic distinction is frequently made between non-renewable and renewable resources. Potential sources of energy such as hydrocarbons and fissile materials clearly come into the first category, but for other types of resource the distinction is often difficult to make. Even minerals could be allocated to the second category since they can theoretically be recycled from both domestic and industrial waste and this would circumvent the problem of their exhaustion.

Water and all resources of a biological origin are usually classified as renewable. Even when polluted, water is not chemically modified in any way by being used and so can be recycled after purification. Plant and animal resources, on the other hand, although potentially renewable, are very often so overexploited that the possibility of regeneration in many parts of the world has been greatly reduced and sometimes completely compromised by the destruction of the ecosystems on which they depend.

In reality, the natural resources of the ecosphere are being wastefully consumed at an increasing rate under the combined effect of population pressure and the dramatic increase in industrial production. The current rate of use takes absolutely no account of the real size of available reserves of minerals or fossil fuels, nor does it concern itself with the rate of renewal of plant or animal resources. The needs of future generations are similarly ignored. In addition to that, malnutrition is spreading in the Third World and, in a future that is closer than some people think, the industrialized and overpopulated countries of Europe and other continents will no longer be protected from shortages of animal protein.

1. See glossary, p. 222.

Another form of damage to the ecosphere which has very worrying ecological consequences is the overexploitation of the Earth's plant cover. The degradation of forests, quite apart from the decrease in timber production it brings, causes irreversible changes in climate and soil. The extension of deserts into grassland or open forests; the erosion of soils in mountainous terrain or in areas where fragile land has been irresponsibly cultivated—these all demonstrate the extent of the upheaval stemming from the overexploitation of natural resources indulged in by humanity.

Animal resources are even more threatened. During the last two centuries, more than 600 species of birds and mammals have become extinct because of human activity. As for marine ecosystems, whose biomass was long considered inexhaustible, these are now also showing disquieting signs of overfishing through excessive landings of the main species of economically valuable fish.

In what follows, therefore, I intend to analyse the ways in which the main categories of natural resource are exploited and to examine the major principles of methods for the rational management and conservation of such resources. Now, more than ever before, is the time for implementing a world strategy for the protection of nature in the cause of a lasting and stable world. The aim of this book is to explain the scientific foundations and methodological approach on which such a strategy must be based.

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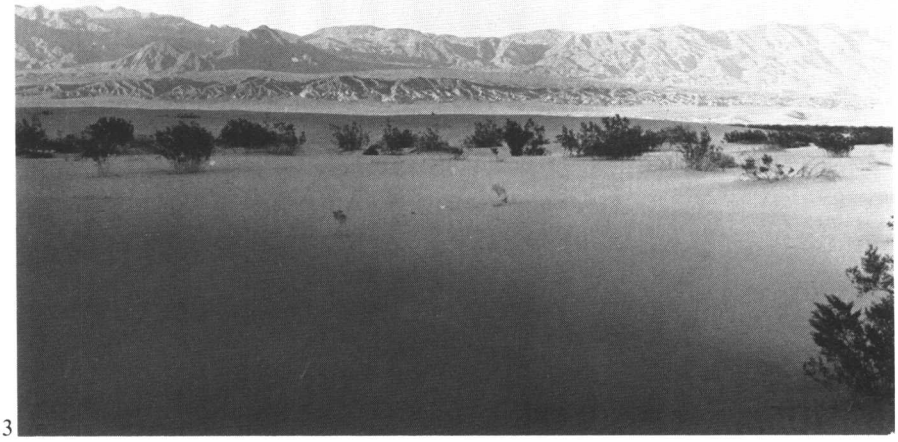

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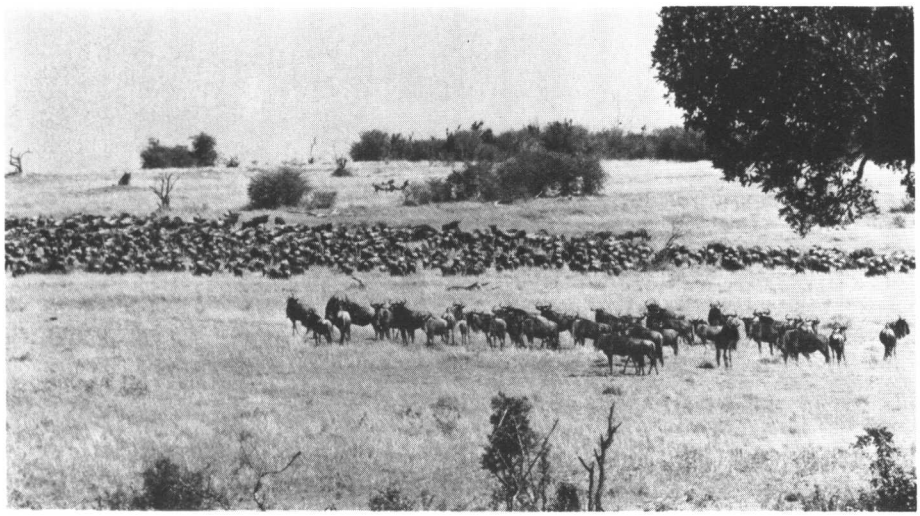
Plate I Limiting factors

1 The sun provides the only external source of energy for the biosphere. Thermo-nuclear reactions occurring in the solar interior (essentially a 'burning-up' of hydrogen) deliver a flux of energy to the ecosphere that has been remarkably constant for close on 5000 million years. Astrophysicists estimate that the sun will maintain its present level of activity for another 5000 million years before becoming a red giant.

2 A tropical rain forest on the slopes of Mount Kenya. In general, the availability of water is a prime limiting factor in continental ecosystems. In tropical rain forests, the high biological productivity and exceptional species diversity are explained by the combination of an abundant rainfall and a stable and favourable temperature.

3 Death Valley in the north of the Mojave Desert in California. Here, the lack of rain produces a low species diversity and a negligible biological productivity
(Photographs F. Ramade)



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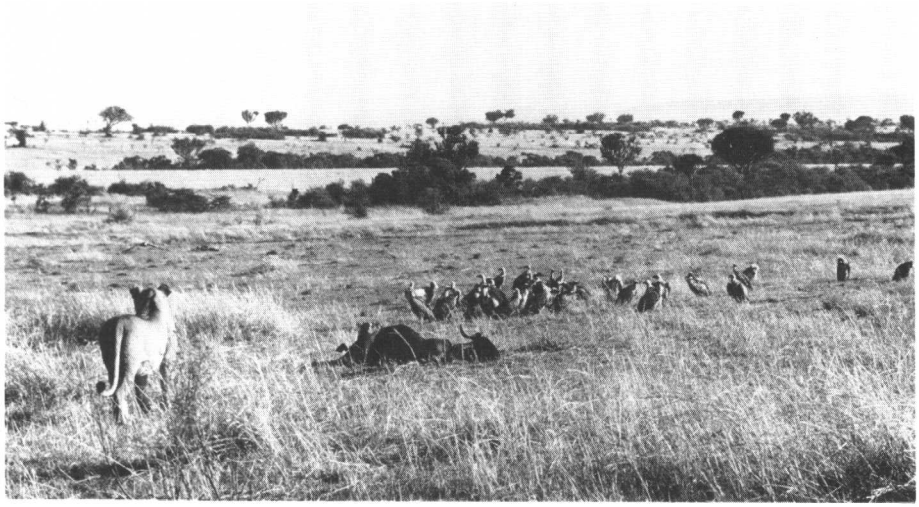

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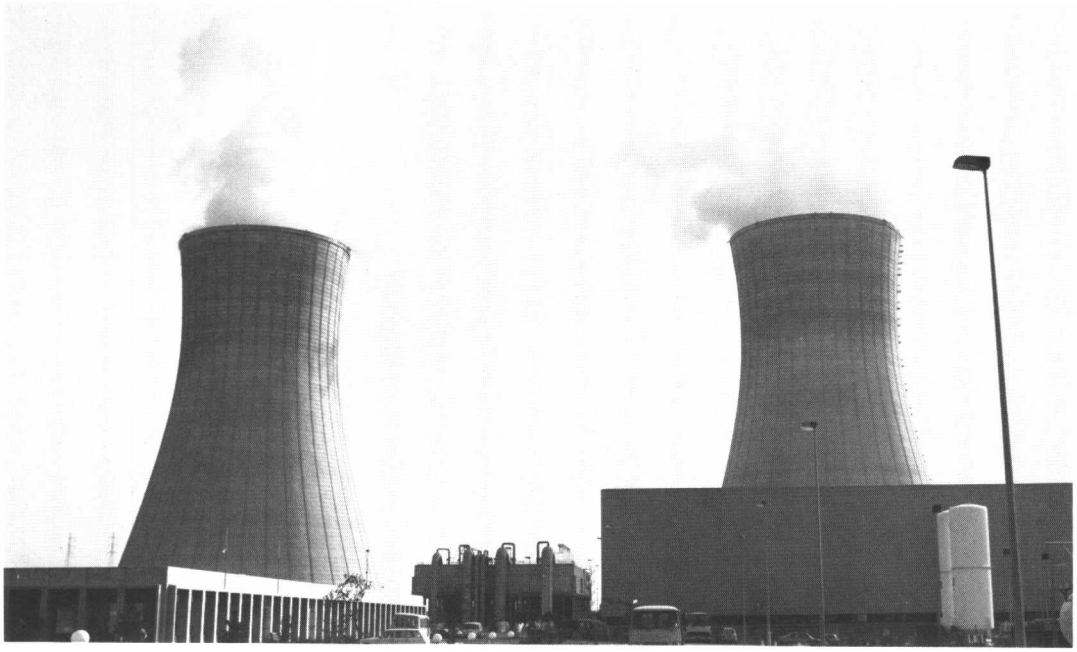
Plate II Consumers and food chains

1 Herbivores form by far the largest proportion of the biomass of consumers. The photograph shows a herd of wildebeest (*Connochaetes taurinus*), a species of antelope dominant in the savannas of East Africa. This is a region in which food chains of the type grasses → ungulates → carnivores still exist undisturbed by human activity, at least in the nature reserves.

2 In the Masai Mara Reserve (Kenya), a lioness prepares to devour a wildebeest she has just killed, while vultures gather, awaiting their chance.

3 A colony of water birds on the banks of Lake Nakuru in Kenya. Cormorants, pelicans and other fish-eating birds are situated at the peak of complex food webs consisting of five or six superposed levels. This feature makes them particularly vulnerable to contamination of the environment by persistent pollutants.
(Photographs F. Ramade)



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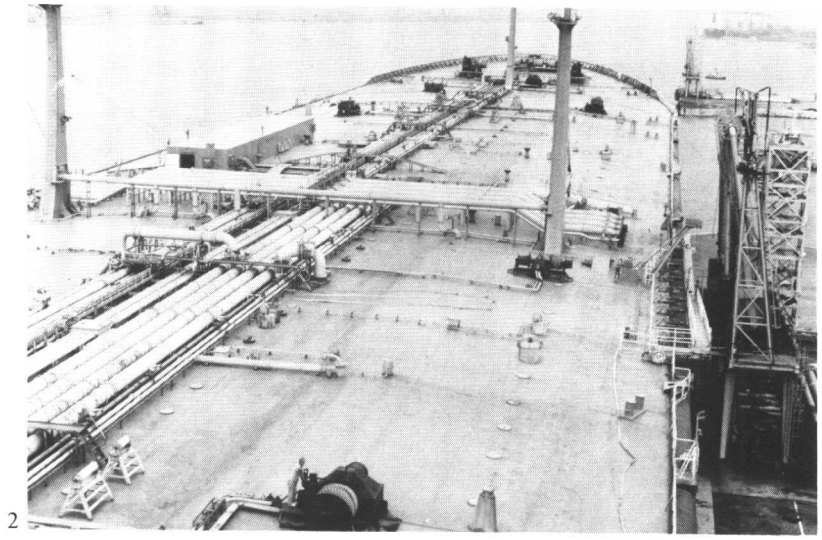

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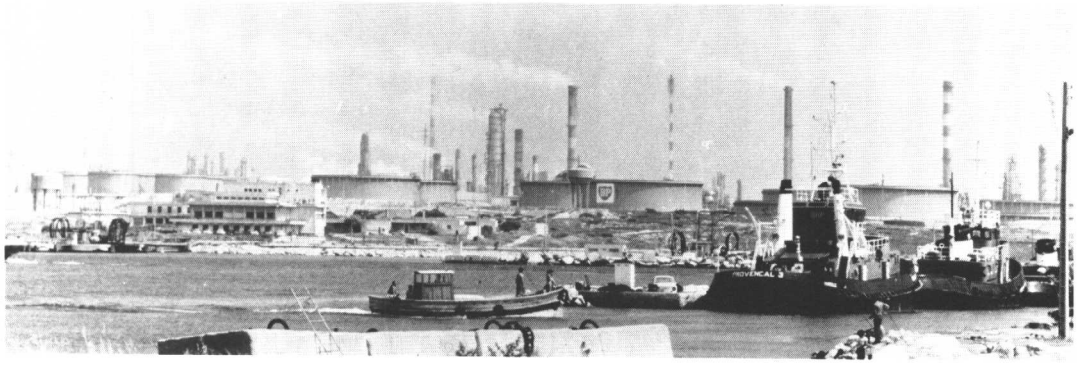

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Plate III Energy and the environment

1 Cooling towers at a nuclear installation. Large quantities of heat discharged at low temperatures by power stations create difficult environmental problems. Cooling by air is tending to become more widespread because it avoids the thermal pollution of continental waters. In addition to their unsightliness, these enormous structures lead to a significant loss of water in the form of vapour, sometimes at a rate as high as several cubic metres per second.

2 A 300 000 tonne oil tanker discharging its cargo at Fos-sur-Mer. World industrial development has been based on oil for more than half a century: unwisely, because it is the least abundant energy source and the most badly distributed.

3 A petro-chemical installation at Lavera in the south of France. The use of heavy fuels rich in sulphur produces a formidable amount of atmospheric pollution whose effects can become apparent a long way from the point of emission.
(Photographs F. Ramade)

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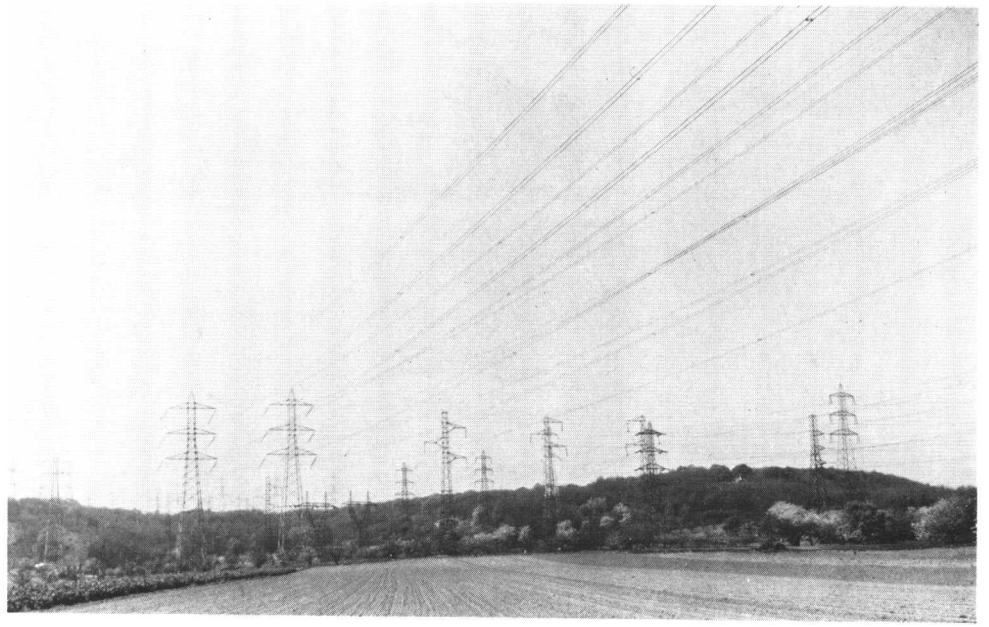

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Plate IV *Energy and the environment*
(continued)

1 A pressurized water reactor (PWR) under construction on the banks of the Rhône at Bugey.

2 High-voltage overhead cables in the neighbourhood of Paris. The development of a sizeable electro-nuclear programme entails the construction of high- and medium-voltage supply lines which will cover tens of thousands of hectares with a continuous network of cables if the policy of burying them underground is rejected.
(Photographs F. Ramade)

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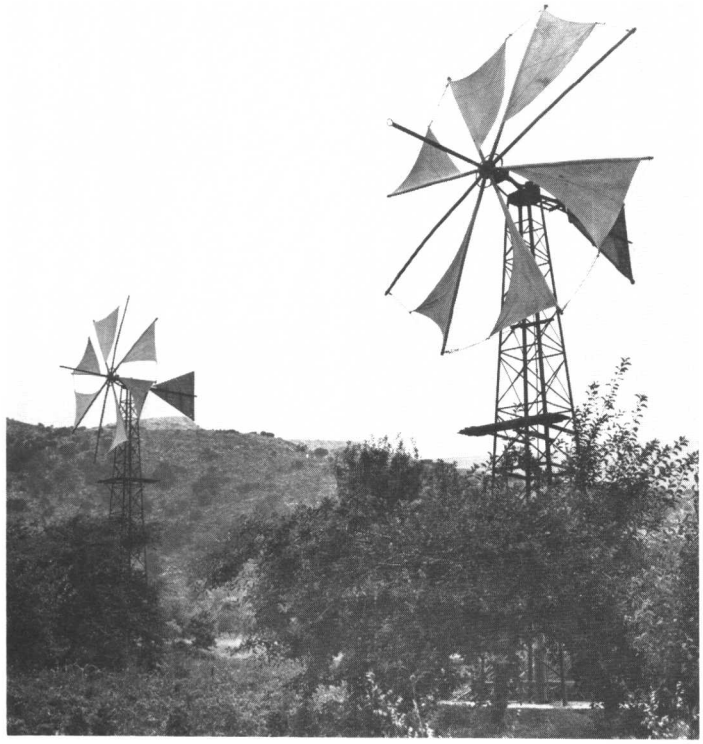

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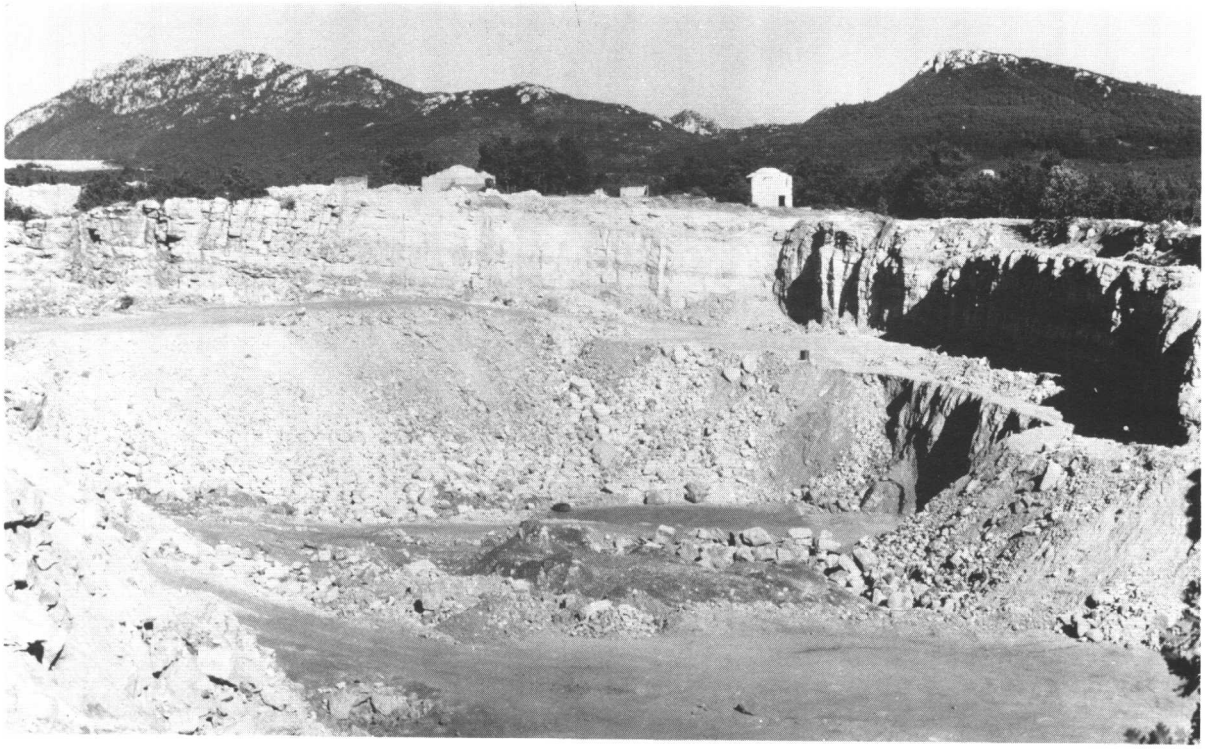
Plate V Natural energy sources

1 Geysers in the Norris Basin in the Yellowstone National Park, Wyoming, USA: the most spectacular form of geothermal energy. While it is true that sources producing steam dry enough to drive turbo-generators are quite rare, the potential resources of low-temperature geothermal energy (for central heating of dwellings, for example) are very considerable indeed.

2 Water pumps for irrigation driven by windmills on the Lassithi Plateau in Crete. It is wrong to think that the use of wind energy is comparatively recent: in fact, it is the oldest source of energy used by humans for mechanical work. The use of modern wind-driven generators could produce the equivalent of several million tonnes of oil per year over EEC territory as a whole.

(Photographs F. Ramade)



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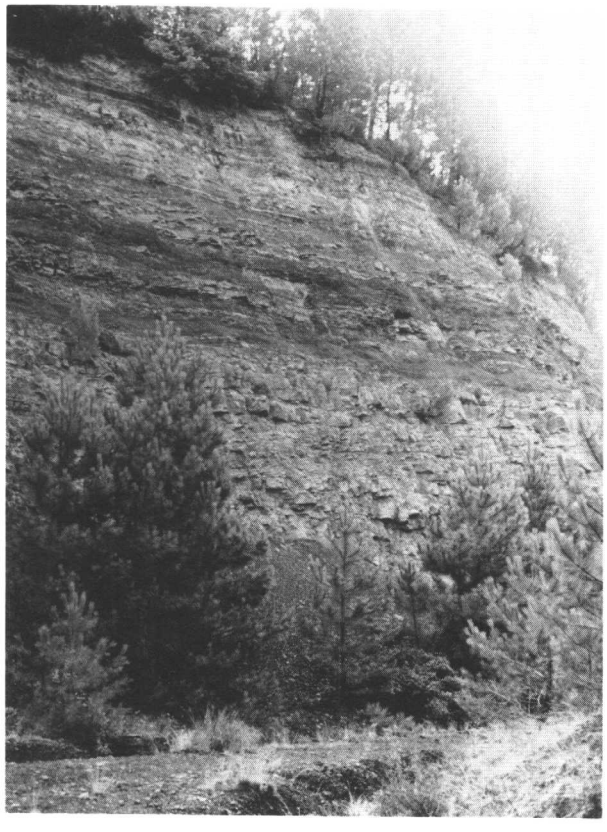

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Plate VI The environmental impact of mineral extraction

1 A bauxite quarry near Brignolles (Var) in France. After being abandoned when the mineral deposits are exhausted, such a quarry cannot be recolonized by vegetation.

2 An open-cast coal mine abandoned several years ago in the Cévennes Basin, France. Reafforestation of mining zones of this sort is a slow and tedious process if the land is not rehabilitated by filling-in after excavation has ceased. Here, a few pines just about manage to grow on the sterile slopes away from the old mine face.
(Photographs F. Ramade)

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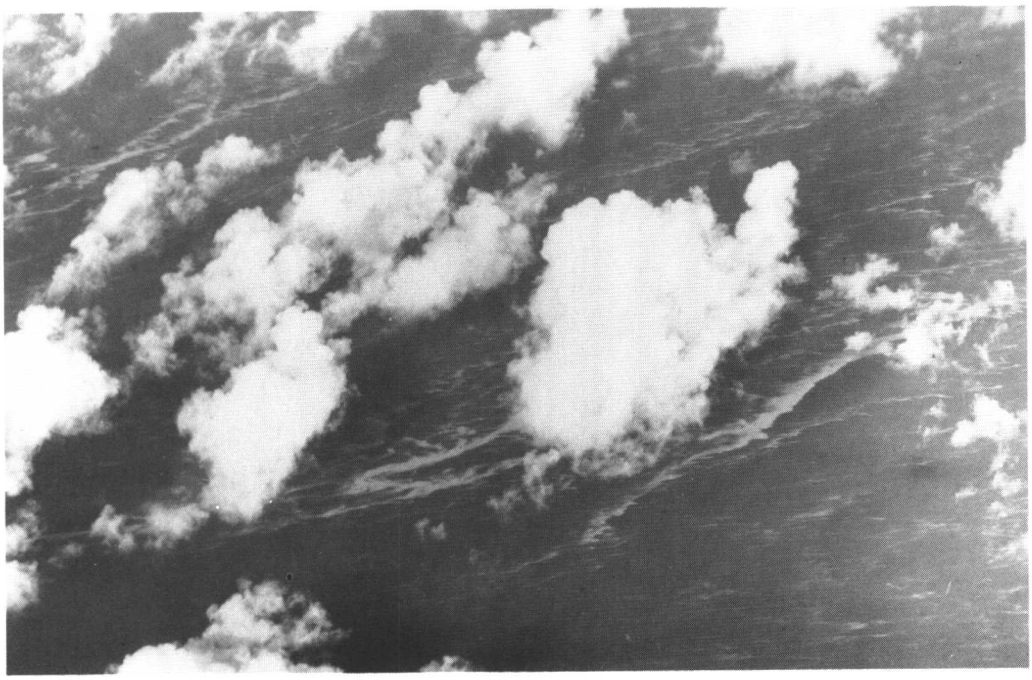

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Plate VII The hydrological cycle

1 The ice-field of north-east Greenland (Peary Land) at the time of its break-up, with many icebergs visible in this aerial view. Most of the stock of fresh water in the hydrosphere is unusable because it is locked up as ice in the Greenland and Antarctic ice fields.

2 Clouds in the process of formation above the South China Sea. Exchange of water between sea surfaces and the atmosphere plays an essential role in the regulation of climate, especially by controlling the water cycle and the composition of the atmosphere.

(Photographs F. Ramade)

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Plate VIII Productivity of inland waters

1 Lake Peyssons in the Andorran Pyrenees. This is an oligotrophic mountain lake with water that is poor in nutrient mineral salts, especially nitrates and phosphates. The relative scarcity of phytoplankton and microphytes is a sign of the low level of primary production.

2 A swamp bordering Lake Neuchâtel, Switzerland. These waters are eutrophic, rich in nutrient minerals, and show a high primary productivity. Note the abundance of algae and microphytes.
(Photographs F. Ramade)

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Plate IX Coastal waters

1 An estuarial zone with sedimentary mud exposed at low tide (Cook Inlet, near Anchorage, Alaska). Such environments, with both a large diversity and a very high biological productivity, are nurseries for numerous species of fish of major importance to maritime fisheries.

2 Salt lagoons in the Camargue nature reserve. In addition to their fascinating aquatic life, such habitats also harbour unusual bird life belonging to the Anatidae and Charadriidae families.
(Photographs F. Ramade)