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OUR PLUNDERED PLANET

OUR PLUNDERED PLANET

by FAIRFIELD OSBORN

This book—which has aroused quite extraordinary interest in America—demonstrates brilliantly and unsparingly that we are following a course which one day may render our good earth as dead as the moon. It contains unmistakable evidence that a continued defiance of nature threatens even the survival of mankind.

Fairfield Osborn (President of the New York Zoological Society) has written out of his conviction that unless public opinion is aroused, and the proper conservation of the natural and human resources of every country regarded as a moral duty, then the earth's fertility cannot continue to sustain her rising population. No nation in the long history of civilization has been more violently destructive of its life-supporting resources than the United States of America—that "country of the great illusion", the country that "can feed the world"! But the problem is worldwide. Fundamental to the troubles not only of nations like China and India, but of all nations, is the misuse of the land by their people; in parts of Russia, in the British Commonwealth, in South America, Mexico, the process is taking place which has made the deserts of central Asia and Mesopotamia.

Our Plundered Planet

by

FAIRFIELD OSBORN

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To all who care about tomorrow

There is beauty in the sound of the words 'good earth'. They suggest a picture of the elements and forces of nature working in harmony. The imagination of men through all ages has been fired by the concept of an 'earth-symphony'. Today we know the concept of poets and philosophers in earlier times is a reality. Nature may be a thing of beauty and is indeed a symphony, but above and below and within its own immutable essences, its distances, its apparent quietness and changelessness it is an active, purposeful, co-ordinated machine. Each part is dependent upon another, all are related to the movement of the whole. Forests, grasslands, soils, water, animal life—without one of these the earth will die—will become dead as the moon. This is provable beyond questioning. Parts of the earth, once living and productive, have thus died at the hand of man. Others are now dying. If we cause more to die, nature will compensate for this in her own way, inexorably, as already she has begun to do.

FAIRFIELD OSBORN

INTRODUCTION

The impulse to write this book came towards the end of the Second World War. It seemed to me, during those days, that mankind was involved in *two* major conflicts—not only in the one that was in every headline, on every radio, in the minds, in the hearts, and in the sufferings, of people the world over. The other war, the silent war, eventually the most deadly war, was one in which man has indulged for a long time, blindly and unknowingly. This other world-wide war, still continuing, is bringing more widespread distress to the human race than any that has resulted from armed conflict. It contains potentialities of ultimate disaster greater even than would follow the misuse of atomic power. This other war is man's conflict with nature.

Perhaps some of the thoughts expressed in these pages will evoke questions of a purely philosophic or spiritual kind, for one cannot think of man in relationship to nature without at the same time querying, 'What is the meaning of man's existence? What significance has the development of man's moral and spiritual qualities? Is there such a thing as Divine Creation?' or, to put the matter simply, 'What is life all about, anyway?' Let the philosophers answer such questions as best they can. The following chapters are incomparably simpler in their scope. They only present some of the many aspects of the relationships of man with

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nature as a whole, and, more especially, with other living things.

The word *nature* is one of the broadest in our language. In its most general sense it refers to the scheme of the universe. In its narrow sense it refers to the character of an individual, or rather the inherent impulse or power by which character is determined or controlled. Nature represents the sum total of conditions and principles which influence, indeed govern, the existence of all living things, man included. It is the intention of this book not only to support the truth of this definition but to show that if we continue to disregard nature and its principles the days of our civilization are numbered.

This book is divided into two parts—the first of which will suggest that man, despite the extraordinary mental accomplishments that have brought about his complex present-day civilization, has been, is now and will continue to be a part of nature's general scheme. The second part of the book is an attempt to show what man has done in recent centuries to the face of the earth and the accumulated velocity with which he is destroying his own life sources. This is that other, silent world-wide 'war'. Its spawn are armed conflicts such as World Wars I and II. Its eventual results, if present ways remain uncorrected, point to widespread misery such as human beings have not yet experienced, and threaten, at the end, even man's very survival.

F. O.

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PART ONE

THE PLANET

I

THE LONG VIEW

Yesterday morning more than 175,000 mothers looked down upon the vague uncomprehending eyes of their newborn babes. Today a similar number are doing likewise, and tomorrow and the next day. All the babies look very much alike, differing but slightly in the colour of those vague eyes or of their strange small bodies, otherwise so much the same whether the child first senses the light of day in Yakutsk or Patagonia, in Shanghai or Brooklyn, in Budapest or London. These are the children of the earth; each day in every land they come, insistently in such numbers, the daily host reproducing the human species the world over. Each day, on the average, there are a few more than the day before. So it is known to have been for the last three centuries. Before that we do not really know, except that there were once, millennia ago, the first few scattered groups of men and women, the original ancestors from whom today's two billion and more have sprung.

So great a company of newborn children, freed from the darkness of their mothers' wombs, become day after day a living part of the environment into which each of them has come. Its strength will be theirs, and its weaknesses. Within the span of merely two lifetimes the size of this daily oncoming host of humanity has almost tripled. Part of the saying of Jesus, 'Blessed are the meek: for they shall inherit the earth,' has been fulfilled. Today humanity, in great and growing num-

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bers, is crowded upon most of the habitable areas of the earth but man's occupancy is marked neither by meekness nor by understanding. The Psalmist who wrote, 'His soul shall dwell at ease; and his seed shall inherit the earth,' experienced a hope for mankind that has been denied by the course of human events. A child who was born only two lifetimes ago, even though he were endowed with the ultimate gifts of prophecy, could not have foretold the developments which, in a sense, are the apotheosis of all previous human history. Within so short a space of time, or within six generations, the numbers of people on the earth have increased from approximately seven hundred million to more than two billion. Continents even recently uninhabited have been 'conquered' and populated. Man's inheritance of the earth is now in truth a completed fact, but as an heir he has disregarded the words of the gentle Nazarene and has already destroyed a large part of his inheritance. He has failed so far to recognize that he is a child of the earth and that, this being so, he must for his own survival work with nature in understanding rather than in conflict. In the recognition of his failures in the past lies his hope for the future and his avoidance of the day of atonement that is drawing nearer as each year passes.



There is a value in what some people call 'the long view'. Perhaps we can best comprehend the human situation today if we first peer through the long vistas of space and time. Who knows? Perspective sometimes provides its own insight.

Our home, the earth, is one of the smallest of the nine planets that belong to a star that we call the sun.

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This star is about 109 times the diameter of the earth, or about 1,300,000 times its volume, a majestic thing to our eyes and in truth the source of our life. Consequently man, during many thousands of years, worshipped the sun as a god, as indeed he had reason to do.

But the sun is, in fact, a relatively insignificant star, a unit in a vast group or system of stars known as a galaxy, in which there are innumerable other stars larger and more luminous. Stars are known that give at least ten thousand times the light of the sun; so huge are they that millions of our own suns could be placed inside them.

In turn, the galactic system in which our earth and sun are placed, known as the Milky Way, is but one among many million similar systems or galaxies. Immense, too, are the distances in the universe—beyond our powers of thought. Occasionally we catch a thread that we hold to and follow, but soon it is lost. For an instant we visualize the speed of light, computing that it travels about seven times around the earth in a single second. The distance of the sun from this earth is then almost comprehensible; light from the sun reaches us in about eight minutes. But our comprehensions soon dissolve when we learn that the explosion of a star in the constellation known as Perseus, that became visible to us in 1901, actually occurred about 300 years earlier, so long did it take the recording light flash to reach us.

We cannot see, we can barely sense such infinities of space, of time and of matter.

What has this to do with man and his future? Are we humans unique—an end-result of a scheme so vast? Or could it be that other planets are inhabited by beings as highly developed as man? Not only those

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planets within our own tiny solar system but those which may exist, perhaps in infinite numbers, elsewhere? If this were so, man's struggle for existence and the advancement of civilization would need, perhaps, to be thought of in a different light. Our human civilization here on this earth, if looked upon from the perspective of the great universal scheme, may in effect have to qualify for survival, measuring up, in the sum total of our actions, to at least the minimum requirements for continued existence attained by other civilizations which perchance exist elsewhere. Though dominant in our own world, our efforts may not be meeting the universal standard.

The possibility that other worlds are inhabited has been an irresistible subject of conjecture for many centuries. In recent decades, aided by giant telescopes, scientists have endeavoured by direct observation of planets without our own small solar system to determine whether or not there was such life. In these explorations it is generally assumed that if conditions of habitability were found to be not unlike those on the earth, life would automatically make its appearance.

Actually there are only two other planets within our own solar system that have been found to be eligible, namely Venus and Mars. Venus would be well adapted for life similar to ours. It is about the same size as the earth, nearer the sun, but probably not much warmer and possesses an atmosphere of satisfactory density. Spectroscopic observation has unexpectedly failed to give any indication of free oxygen in the upper atmosphere and this suggests a doubt as to whether free oxygen exists on that planet. Consequently, it is not yet definitely known whether or not there is free oxygen there. There is, however, much carbon dioxide

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present. Venus is completely covered with cloud or mist and therefore studies of its surface cannot be made.

The surface of Mars, however, is clearly visible. Air and water are both present, though scanty. Its atmosphere is thinner than the earth's but is perhaps adequate for life. It is probable that it contains oxygen. The surface markings of Mars represent red desert and darker ground, the latter suggesting areas that are moist and fertile. A large white area covering the pole of Mars is clearly a deposit of snow, although as this melts away in the summer it must be quite shallow. While clouds occasionally blot out large areas, clear weather is usual. The apparent existence of vegetation on Mars is correlated with the probable presence of oxygen. Rocks in the earth's crust absorb oxygen and would in due course bring about its complete disappearance from the air, were it not that green plants give off oxygen in the process of photosynthesis. It seems fair to assume that vegetable life is required to play the same part on Mars. Even granting that vegetable life exists on Mars, can it be assumed that animal life exists there? This question cannot be answered, although since plants and animals both developed together on the earth, it seems probable that they have both developed together on Mars. It has even been argued that certain more or less straight markings on the planet represent an artificial irrigation system and are indications of an advanced civilization. One other observation regarding Mars is pertinent. It is a planet that has long passed its prime and it is not probable that two planets, differing as much as the earth and Mars, would at the same time be in an equivalent stage of biological development.

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Whether or not life similar to man's exists on the planets within our own solar system, the fact remains that of the innumerable millions of planets that presumably exist within the universe as a whole, a great number would have physical conditions very similar to those prevailing on earth. The same chemical atoms exist elsewhere as exist here and they must have the same properties, so that it is probable that the same inorganic compounds are formed elsewhere as are formed on this earth. However, science has as yet been unable to answer the question as to whether there is human life elsewhere in the universe. We go back to our first thought. If there are other human civilizations, perhaps even great numbers of them, are we meeting the problems of living and survival as successfully as they?

These conjectures as to the existence of life similar to man's elsewhere in the great scheme of nature may indeed be purposeless. In any case they are tantalizing because of our incapacity to imagine such a possibility. Nor do we relish the penetrating sense of insignificance that such thoughts bring. After all, is it not written that 'man is the lord of the universe'? Perhaps—and yet?

It is apparent that human life on this earth, represented by our civilization, is but an element in the great scheme of nature, boundless and immeasurable. Leaving behind us the difficulties of attempting to find specific clues regarding man's existence and future destiny from the perspective of the universe as a whole, what light, if any, is thrown on the subject by glancing at man's origins, the environment of his primitive days, and his early life on the earth? From his primitive environment, man formed characteristic

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habits of thought and action, became subject to certain emotional reactions, acquired, in fact, his personality. It is now thought that human beings, recognizable as such as distinct from apes or monkeys, existed at least a million years ago—possibly even longer. What we call the *history of civilization* runs back less than 1 per cent of that total time. Applying the time-span of human existence to the life of an individual, say thirty years of age, it is as if the individual had lived as a savage for more than twenty-nine and a half years of his life and had come under the influence of present-day social and civilized environments for less than four months. The analogy obviously is not quite fair, for human beings are adaptable and learn quickly. Yet the fact remains that many of our characteristics—good as well as bad—stem back unchanged to the primitive periods of human existence. One of them—the impulse to dominate as well as to destroy—is proving continuously disastrous not only in the political and social sense but in the physical sense. It is in the latter regard that this book is written, for man's destructiveness has turned not only upon himself but upon his own good earth—the wellspring of his life.

Our knowledge of the extinct ancestors and early relations of man still has many gaps. By contrast, the evolution of the modern horse, for instance, from his prehistoric ancestor, the small, four-toed eohippus, is clearly traceable from fossil remains, the oldest of which reached back to the Eocene period, some 50,000,000 years ago. There are also other mammals where such a wealth of fossil material has been unearthed that much is known concerning their successive evolutionary stages. This holds especially true, for example, in the case of elephants, camels, rhinoceroses,

wild cattle and even of anthropoid apes. The latter naturally are of especial interest and will be commented on in a moment.

In considering the reasons for the relative scarcity of fossil remains of the ancestors of man, we should first take our bearings as to what we mean by such ancestors and the connections they may have with what Earnest Hooton terms 'man's poor relations', the anthropoid apes—namely, the gorilla, the chimpanzee, the orangutan and the gibbon.

The similarities between man and the anthropoid apes are so numerous and so intimate from an anatomical and a physiological point of view that there is nothing to be served, within the scope of this book, by elaborating upon them. On the other hand, there continues a prevalent misconception concerning the theory of man's origin. The results of scientific inquiry, which have brought to light a very large amount of evidence that man and present-day apes had a common ancestor, have been interpreted in the popular mind to mean that man is 'descended from monkeys', implying that the anthropoid apes, as we know them today, are the ancestors of man. This misinterpretation of the scientific point of view is of long standing. It seems to have had its inception at the time of the publication of Darwin's *The Origin of Species*, a book that had a profound effect on the whole current of human thought. Yet Darwin's expression of his theory was: 'If the anthropomorphous apes be admitted to form a natural sub-group, then as man agrees with them . . . we may infer that some ancient member of the anthropomorphous sub-group gave birth to man.' When first published, his book was nevertheless so shocking to human sensibilities and the age-long belief

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that God created man on the sixth day that Church, State and the man in the street joined in defence against it. Because of the principles that Darwin enunciated, however, human beings have been brought to the realization that we are of the essence of life history on this earth, sharing with other living things innumerable similarities.

While there is no case history step by step as complete as that of the horse and certain other mammals, there is a large accumulation of evidence that far back in the earth's history there evolved a prototype or primitive stock, which, through subsequent and *diverging* evolutionary stages, produced two types of descendants—man, on the one hand, and the apes and other more highly developed forms of monkeys on the other. This prototype, or primitive form, existed several million years ago when the branching-off point in evolution to man and to the apes occurred. In recent years scientific thought is pushing man's origin further and further back into time, and anthropologists now tend to believe, as stated above, that he has existed in a form fairly similar to his present one for approximately a million years.

There are several reasons why so few fossil remains of early man have been discovered. First among them is the likelihood that the earth's population of primitive man at any given period was an extremely limited one. It is a startling fact, referred to in some detail in a later chapter, that the human population of the earth as recently as the seventeenth century was only slightly in excess of 400,000,000, or about one-fifth of what it is today. Although no comprehensive studies of human world population were made prior to that time, circumstantial evidence indicates that this figure

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had not previously been exceeded, and the likelihood is that man, through the hundreds of thousands of years of his early development, had slowly increased in numbers from a very limited original stock.

In comparison, the world populations of many prehistoric larger mammals, of which fairly complete fossil records have now been found, were undoubtedly very large indeed. A good illustration of this is provided in North America. Much evidence has been accumulated that this continent in prehistoric ages contained immense numbers of the various kinds of animals then existing, including horses, camels and mastodons. The wealth of fossil material found in other parts of the world indicates that the earth was inhabited by large numbers of animals of different kinds, many of them now extinct either through lack of ability to adjust themselves to their environment, or, more recently, because of the successive Ice Ages, the first of which occurred at the beginning of the Pleistocene era about a million years ago. There is a quite recent illustration of the great numbers of large mammals as compared with the extremely limited numbers of human beings. When the white man first arrived in North America there were approximately 1,000,000 native Indians north of the Rio Grande, this figure representing the estimated number of individuals in all the tribes in the United States and Canada. By contrast, the populations of horned animals in this area ran into innumerable millions. Of bison alone it is estimated that there were at least 50,000,000. In addition there were immense herds of elk, deer, caribou and antelope, together with considerable numbers of moose. Another recent illustration can be seen in Africa, which, when first visited by the white races,

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contained vast populations of the larger forms of wild-life, in comparison with which the native human populations were fractional.

Man then, through the long ages, has always been in the small minority as far as numbers are concerned, and consequently, because of his rarity, the chances of finding any considerable number of his fossil remains have been and presumably will continue to be slim indeed.

Another difficulty in tracing man's early history by means of his fossil remains is that he is, relatively speaking, a newcomer on the face of the earth, and consequently his remains do not exist in the rocks of early geological periods. Becoming a fossil is at best a complicated business. It frequently involves a process through which bone tissue becomes impregnated, or replaced, by minerals. Thus the original bone shape is retained, turned to rock, and rendered imperishable instead of decaying and disappearing. In other words, the remains of a dead animal generally cannot become fossilized unless they are covered by mineral-containing or otherwise preservative materials within a reasonable period after death and before exposure to air and water will have completed the process of dissolution. Perhaps the principal reason why human fossils are rare is because early man, like other early primates, lived mainly in forested country, an environment not conducive to the preservation of animal remains as fossils. One of the striking characteristics of fossil records is the comparative rarity of forest-dwelling animals as contrasted with the abundance of plains-living animals. The higher order of intelligence that man possessed from the time of his earliest existence also must have served, curiously enough, to prevent

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his remains from becoming fossilized. He doubtless was always clever enough to avoid the pitfalls that caused the death of many animals, such as falling into swamps or the marshy edges of lake beds. Of the latter type of accidents there are, it will be recalled, some striking examples such as those that befell so many of the ancestors of the present-day elephants, known as the mammoths, when they were roaming North America and met their end in swamps or sink-holes; or even the case of the tar lake near Los Angeles which, like a magnet of death, drew to its treacherous depths a host of animals, the finding of whose remains, perfectly preserved, has provided what is perhaps the most dramatic glimpse of the earth of yesterday. In that time, about forty thousand years ago, there lived a great society of animals—imperial mammoths, camels, jaguars, often called 'sabre-toothed tigers', giant ground sloths, wolves, bison and horses. Most of these forms are now extinct. Their capacity to meet the conditions of survival was not sufficient.

II

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But just of late he has emerged. He has gained comprehension. His mind reaches out to distant star galaxies. The splendours of his civilization are beyond description—and so are its horrors. The blessed touch of the Creator gives him a soul that lifts him to glory. But often he falls.

These glances at the earth-home of mankind and at the origins of human development do more than suggest the inherency of man in a universal scheme. He has spent all but one-hundredth of his life as a primitive being, living in what is called by some a savage state, by others, a state of nature. It would be of interest to look at some of the factors in man's earlier environment, to observe, for a moment, some of the conditions in which mankind has spent its *growing-up* period. Motivations, as well as reactions of various kinds, generally result from earlier experiences. To what degree are old acquired habits, and our instincts, at the bottom of some of our troubles? There is a sound and clarifying definition that has a bearing on this question. It runs: 'There is no intelligence in which some traces of instinct are not to be discovered, more especially no instinct that is not surrounded with a fringe of intelligence . . . neither intelligence nor instinct lends itself to rigid definition: they are tendencies, and not things.' This statement has implications worth pondering in connection not only with the

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course of recent history but also with the behaviour of individual people.

The most cruel and deadly world-wide war has recently run its course—a war marked by horrors and atrocities from whose memory we are still attempting to recover. What, if anything, was there in man's ancestry, what inherited tendencies, what instincts that human beings possess which could account for such actions? At least a partial answer is found in the study of early man. The uncomfortable truth is that man during innumerable past ages has been a predator—a hunter, a meat eater and a killer.

The branching-off point in the evolution of man from that of the anthropoid apes was marked by the development of living habits in the primitive ancestors of man which has proved far from an unmixed blessing for the human race. Man, at an early stage, became a hunter and a killer while his nearest relatives in the animal world most similar to him physiologically remained vegetarians, and at no time, even to the present day, have depended upon the lives of other living creatures for their own survival. It is unlikely that all primitive humans were predatory, and consequently it is probable that considerable groups of primitive people were plant and fruit eaters, especially those people living in tropical or subtropical regions. But the explosive, dominant groups, which appear to have made the strongest impact on the course of human civilization, particularly those living in the temperate zones, resorted in the earliest times to hunting, combat and killing. Stone weapons have been found that were used by human beings who lived in the Paleolithic era, or more than 100,000 years ago. In pre-Paleolithic times extending back to about 500,000 years ago, there

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was a form of primitive man technically known as *Sinanthropus*, and more intimately spoken of as the Peking man, who evidently used fire and around whose remains animal bones have been discovered suggesting that animals had been used by him for food. In these same faraway periods of man's development numerous discoveries have been made of long bones that were apparently cracked open for the marrow. All the evidence points towards the fact that the Peking man and his contemporaries were extremely ferocious, made a practice of breaking up other human bones, and were cannibals. It is difficult to avoid the conclusion that tendencies of an extremely combative nature were deeply ingrained in the instincts of the human race.

In this connection we still continue to attribute to other kinds of living creatures characteristics that are ours but not theirs. There are many instances of this. In the case of man and the anthropoid apes, for example, man attributes qualities to this group of animals which they do not possess at all. The gorilla is pictured by cartoonists, and is thought of in the popular mind, as a bloodthirsty killer. This is not the case. Gorillas are vegetarians and in their natural state do not go out of their way to harm other living things, the power and dominance of the male being reserved for the protection of his own family or social group.

There is another aspect of this matter bearing on our inherited instinctive tendencies. This has to do with man's fear and anger reactions; closely related psychologically, the latter emotion is frequently the result of the former. Man is in most respects a generalized type of animal, not a specialized type. He was always able to do a number of things pretty well but excelled at nothing except in the use of his wits and his

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hands, which saved him from extinction. Primitive man was surrounded by many types of animals that were better equipped physically than he in that some were larger and stronger, some were swifter, and others, such as the horned and tusked animals, were provided with their own body weapons, useful for both offence and defence. Man even lost the agility of rapid climbing which his nearer relatives, the apes, retained, and which enabled them to gain safety from enemies on the ground. In this environment and under these substantial handicaps, man survived principally owing to superior intelligence, his most striking characteristic from the earliest days of his evolution. As time has gone on the development of man's brain has proved itself to be one of the most extraordinary cases of specialization to be found in nature. It is of course true that fear reactions, of varying kinds and degrees, are deeply ingrained in the psychology of most living things. As far as early man is concerned, it is apparent that he developed in an environment where other living creatures more powerful than he constantly threatened him, and consequently the fear motivation was common to him. Slowly, however, he acquired the capacity for self-protection and developed his own means of aggression. The fear complex must frequently, then, have turned to anger or even pugnacity. We can see around us today constant examples of the workings of these long-established instinctive reactions.

While on the subject of combativeness, it may be pointed out that warfare as practised by man has no parallel in nature. This is to say that within the more highly developed animal populations of this earth there is not now nor has there ever been similar de-

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struction within a species itself. In fact, one has to go to the lowliest forms of animal life, such as certain kinds of ants, to find anything comparable to human warfare. It is a curious fact that mankind appears to justify the killing of his own kind by assuming that it is a 'law of nature'. There are a lot of current misconceptions about the laws of nature, of which this is one of the most erroneous and fateful. Political ideologies have been based upon it with results that have come near to destroying human civilization. The theory that war is a biological necessity, that it is nature's method of controlling population and assuring the survival of the strong and the elimination of the weak, is inaccurate and untenable. Within the last century, when wars have been common all over the world, the human population of the earth has almost doubled.

The principle of 'the survival of the fittest' has quite a different meaning from that commonly attributed to it. Darwin's conclusions were drawn from his long observations of the methods of living things, which led him to conclude that those kinds survived that were best able to adapt themselves to their environment, not those that were most competent in mass murder. It is further to be observed that when all of the larger and higher types of mammalian animals are considered, the carnivores, namely those that live upon the lives of others, are merely outliers among the great animal populations—a minority party indeed. It is estimated that the number of carnivores or killers would not exceed 1 per cent of the total animal populations as they originally existed in Africa or North America—that is before man decimated the wildlife of these continents. Only in exceptional cases in higher forms of animal life is there organized killing within a species ~~itself~~, and

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even combat is rare except in defence of members of the immediate family or social group, or when males are seeking dominance.

The consideration of early man combined with the contemplation of certain well-established zoological principles brings out another thought that has a distinct bearing on what is presumably the most pressing problem of world society today—namely, that of the relationships of races and nations. The basic similarity, from a biological point of view, of all peoples on the face of this earth has only been made clear recently through the development of the sciences of anthropology and genetics. If one attempted to define the technical physiological differences of peoples of various nations and countries, it would only be done with the greatest difficulty, owing to the fact that all known races of man are fertile one with another and that from time immemorial localized groups, which by long inbreeding have acquired distinctive characteristics, have been spreading outward from their homelands, invading each other's territory and producing the countless mixtures that exist today. What is known as *parallelism*—that is, the development of similar characters in different derivatives of the same stock *after* they have drifted apart—makes it hazardous to assert that all mankind is derivable from common ancestors; they may have sprung from related forms of pre-men. The zoological term *species*, although difficult of precise definition, is well understood and generally accepted to denote a differentiation of kinds of living things. In applying this term to human beings and attempting to differentiate the peoples of the earth into different species, a scientist is faced with a very difficult problem, assuming of course that he uses the

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same methods of classification that are applied to other forms of animals. An attempt to classify by structural differences provides only partial solution because there is great similarity of structure between individuals in racial groups far removed from one another. The saying, 'We are all brothers under the skin' has a basis in scientific fact. Interbreeding between different species of animals in their natural state rarely takes place and any unions that may occur between the members of different species are almost always unproductive. In contrast, all different types of human beings are capable of interbreeding freely. The antipathies of nations and races, the cults of 'superior' and 'inferior' races, cannot be founded on biology.

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In the parlance of the biologist, a 'generalized' animal is one which has adhered to the general, standard form of its ancestors as if guided by the determination to progress conservatively and without distortion, or even not at all.

In contrast, 'specialized' animals are those that are strongly developed in one or more particular ways. Figuratively speaking, they 'choose' a special way of living and cast their fate and pin their hopes for survival on the expectation that the conditions surrounding them will remain approximately as they are. The animal world is rich with examples, some of which border on the grotesque, such as the anteater, the sloth, the giraffe and the hippopotamus. Although the advantages of specialization are clear enough, the disadvantages are very substantial. A basic one is that, as a general rule, the process of evolution is irreversible. While there are exceptions to this rule it is usually the

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case that once the trend is well under way there can be no withdrawal. In effect, this spells a commitment to a special environment.

Many living things have characteristics which permit them to be classified as either generalized or specialized types. This distinction can be applied, more or less appropriately, not only to the higher forms of animal life but downward through the scale even to plant life.

Man is one of the best examples of the generalized type. Early man, as observed above, lacked notable or specialized physical endowments. He excelled at nothing except in the use of his wits and in the capacity of doing things with his hands. His survival was due principally to his use of his growing intelligence in a scene where many competing forms of life were either stronger or swifter or endowed with other physical characteristics, of a specialized nature, which protected them. From a physical point of view man is still a generalized animal, only three characteristics being specialized. The first is the human eye, which is intricate and highly developed and capable of seeing in three dimensions as well as in colour. Another of man's specialized characteristics is the foot. This is a wonderful mechanism, in that the elemental primate foot has been 'made over' into an arched platform, able to apply a powerful force at the ball, and consequently the only foot that can take a human step. Because of this man is able to move with facility in an upright position, an accomplishment possessed by no anthropoid apes. Finally, there is the human brain, undoubtedly one of the most extraordinary cases of specialization to be found in nature. Can it prove an instrument of foresight and wisdom as well as one of amazing ingenuity?

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A survey of the innumerable and various kinds of living things that have existed on this earth since the beginning of the Paleozoic era, approximately 500,000,000 years ago, indicates that the major tendency of evolution is towards specialization, which proves successful as long as conditions do not change. But in studying the present and in looking backward over the vast panorama of cycles and ages of this earth's history, one thing becomes perfectly clear and that is that conditions are constantly changing, even though, as a rule, almost imperceptibly. Faced with changing conditions, life must move to similar conditions, or change to meet changed conditions; failing to move or change it perishes. As a rule the choice was not made, or there was an incapacity to make it. More kinds of living things have become extinct than exist today. The price of survival is high.

It will be immediately apparent that, judged by his physical make-up, man is extremely generalized, which contributes to his capacity of adapting himself with readiness to the extremes of physical environment. It is likely that no other form of living thing, certainly no other mammal, has ever developed an equal capacity. Man can exist in the extreme cold of the polar regions, in the attenuated atmosphere of the earth's highest mountains, in desert heat or in the pervasive humidity of the tropics. Does this amazing capacity ensure his survival? Perhaps, if there were not other far more compelling circumstances to consider.

The essence of man's situation is slowly becoming obvious. His physical adaptability, in the pattern of biological history, provided, until recently, its own guarantee of his survival. The characterizing of man as

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a generalized type, and therefore as one most capable of adaptation to changing conditions, seems illogical now—outdated by the course of events of even the last few decades. Today one cannot think of man as detached from the environment that he himself has created. True, one never actually was justified in doing so. Yet even as recently as the latter years of the last century, the projections of man's mind in the form of the physical changes he was effecting on the earth itself were not of sufficient extent to be recognized as a new and profound change in the evolution and even in the destiny of mankind. The groundwork had been laid in earlier centuries. The explosion, world-shaking, has occurred in this one. The mechanical, chemical and electrical sciences, man's mind-extensions, are changing the earth. A concept, recently expressed, speaks of man as now becoming for the first time a *large-scale geological force*. The effects upon man's social and political relationships are not within the immediate scope of this book, although the present world-wide disturbances in human civilization can at least partially be accounted for by the havoc, described in subsequent pages, that man is working upon his natural environment. These disturbances will unquestionably increase in violence, even to the point of social disintegration, if the present velocity of destruction of the earth's living resources continues. Man has it in his power to stop this havoc. He also still has it in his power to remedy enough of the damage that he has caused to permit the survival of his civilization. The question is, Will he do it and will he do it in time?

Man, then, has exchanged the safety and flexibility of generalized characteristics, which since his primitive days have largely contributed to his survival, for

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extreme specialization. Through the development of the physical sciences, funneled into vast industrial systems, he has created and continues to create new environments, new conditions. These extensions of his mind-fertility and his mind-restlessness are superimposed, like crusts, on the face of the earth, choking his life sources. The conditions under which he must live are constantly changing, he himself being the cause of the changes. In this metamorphosis he has almost lost sight of the fact that the living resources of his life are derived from his earth-home and not from his mind-power. With one hand he harnesses great waters, with the other he dries up the water sources. He must change with changing conditions or perish. He *conquers* a continent and within a century lays much of it into barren waste. He must move to find a new and unspoiled land. He must, he must—but where? His numbers are increasing, starvation taunts him—even after his wars too many are left alive. He causes the life-giving soils for his crops to wash into the oceans. He falls back on palliatives and calls upon a host of chemists to invent substitutes for the organized processes of nature. Can they do this? Can his chemists dismiss nature and take over the operation of the earth? He hopes so. Hope turns to conviction—they *must*, or else he perishes. Is he not nature's 'crowning glory'? Can he not turn away from his creator? Who has a better right? He has seemingly 'discovered' the secrets of the universe. What need, then, to live by its principles!

III

THE NEW GEOLOGIC FORCE: MAN

Before taking a closer look at this earth-home in which more than two billion human beings are trying to work out their survival, let us first consider the drastic change in the world picture resulting from the spectacular and cumulative series of modern inventions. In more ways than one the earth is far from being what it was—even the other day.

Space, as well as time, is relative and our conceptions regarding both are constantly changing. Modern thought has come to recognize that space and time are closely interrelated. This realization has produced, within the present century, a new theory concerning the cosmic scheme, including even a new definition of infinity. While a concept having to do with the remote boundaries of the universe is not directly pertinent to the consideration of man's relationship with nature and, more particularly, with his own living spaces, we find that within recent decades our entire point of view concerning this earth-home of ours has also undergone a major change. The remarkable development of the technical sciences has caused the earth, among other things, to become constantly smaller. In an earlier chapter the earth was referred to as one of the minor planets belonging to a star of moderate size. In itself this description is of no particular import, principally because it involves a consideration of size, or space, without relationship to time. Speed of communication

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and rapidity of transportation are eliminating distance. Yesterday we began using the moon's surface as a reflecting board for radar messages to the other side of the earth. Not so long ago—in the sixteenth century to be exact—a round-the-world trip, or message, took more than three years. Now it is possible to dispatch a message around the earth in a few seconds and to travel around it in less than four days.

So it is that the earth is constantly becoming smaller, or rather our knowledge of it is leading us to think of it as diminishing rapidly, which, after all, amounts to one and the same thing. As a consequence we are now thinking of mankind in terms of a world society. The boundaries or barriers between localities, nations, even continental populations, are dissolving. From a social or political point of view the process is slow and intensely painful—marked by rancour and bitterness, jealousy, and warfare of unbelievable destructiveness. From a physical point of view, that is insofar as human beings themselves are concerned, there is no actual change. It is merely that people the world over are coming to realize the essential unity of mankind. The earlier reference to the likeness of all human beings, the fact that from a biological point of view no nations or races are disparate, that human beings throughout the world are of one species—or at most divided into groups or sub-species, all closely similar—makes this change in our conceptions of human civilization unavoidable and inevitable. Further, owing to the existence today of world-wide systems of commerce, combined with new and so-called higher standards of living, all nations are dependent upon others in varying degrees for products, materials or goods that have become a necessary part of every-

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day living for most of the people on the face of the earth.

The conditions—whether material or social or even ideological—which exist among peoples in one section of the earth now have a bearing on the lives of peoples of far-distant nations. No longer is an American unaffected by the trends of living conditions of other peoples, whether those of a country in the Western Hemisphere or even those on the exact opposite side of the earth. No longer can 3,000,000 people in India die of starvation, as they did in 1943, without a specific and cumulative effect on an Englishman in Sussex. The spoiling of the land and the ensuing destruction by floods in the great Yellow River Valley of China soon or late, in one manner or another, impinge on the well-being of peoples one thousand horizons away. The peoples of the earth, whether they will it so or not, are bound together today by common interests and needs, the most basic of which are, of course, food supply and other primary living requirements. These come, all of them, from nature and from nature alone—from the forests, the soils and the waterways. Man's problem in his earliest, dimmest, most faraway days was obtaining a living from these elements. The wheel of human destiny seems to turn, but the basic facts of life remain constant. Man's initial problem is still with him—can he obtain a living from nature? The population of the earth has increased almost five times within the last three centuries and doubled even within the last century. Human civilization has permeated virtually every living area of the earth's surface. As will be shown in later chapters, vast fertile areas in various parts of the earth have been injured by man, many of them so ruined that they have become deserts and uninhabit-

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able. In such places flourishing civilizations have disappeared, their cities buried under wastes of sand, their inhabitants scattering to new lands. But *now*, with isolated and inconsiderable exceptions, there are no fresh lands anywhere. Never before in man's history has this been the case.

Actually the earth, from the point of view of its use as a place to live in, is far smaller than our minds picture it. We retain, even after we are grown-up, our first childhood impressions of the vastness of the 'great round earth'. We are apt to forget that almost three-quarters of the earth is covered by water and that at least one-half of all the land is uninhabitable because it lies in the polar regions or is extremely mountainous or is desert land. Consequently, there remain only about twenty-five million square miles, equivalent in round figures to about sixteen billion acres, that can be thought of as originally favourable to habitation by man. Divided by the number of people alive today, this would mean a theoretical maximum of less than 8 acres of naturally habitable land for each human being if the total habitable regions were divided equally. We must of course envisage all types of land, including those covered by forests, lying in grasslands, or those favourable to the cultivation of crops. In the present state of statistical knowledge we cannot estimate with exactness the proportions of the entire habitable areas of the earth that are devoted to the different uses to which man has put them. We do know that a very large proportion of the originally habitable areas have already been so misused by man that they have lost their productive capacity. Extensive areas of man-made deserts—sterile, barren, beyond reclamation—exist on every continent. Innumerable other areas, all

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over the earth, have been robbed of so much of their value that they are barely worth cultivation; the products from these lands possess little energy content; the people are undernourished.

As to the remaining amount of land that can be used for cultivation, the productive soil of the world is now so limited that it is estimated there are not more than four billion acres of arable land left to fill the needs of more than two billion people. A study made by the United States Department of State reports that the area of cultivated land in the world before the outbreak of World War II was somewhat less than two and one-half billion acres. If one takes the larger figure of four billion acres, representing the area of land estimated as now available or suitable for cultivation, it means that there are less than two acres per head. Contrasted with this it is a generally accepted computation that two and one-half acres of land of *average productivity* are required to provide even a minimum adequate diet for each person. Many countries have less than an acre of productive land per head. No wonder there are world-wide shortages, and that the people of a number of nations are facing starvation.

Blind to the need of co-operating with nature, man is destroying the sources of his life. Another century like the last and civilization will be facing its final crisis. While there is a growing, frightened awareness of the oncoming peril—while in some countries corrective steps of almost sufficient vigour are being taken—the fact remains that the turning point of recovery and reclamation has not yet been reached in any country. The issue has not yet been met. The third of the Four Freedoms, 'Freedom from Want,' Dumbarton Oaks, the San Francisco Conference, the United Nations

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meetings—all of these reachings of the human mind and spirit for a better world will prove meaningless and futile until this issue is met; until, through world-wide planning, we first protect what remains and then take steps, wherever possible, to start back on the long, slow road of reclamation.

This road can be found and travelled only if there is general understanding of the problem that confronts us and over-all programmes, international as well as national, are devised to cope with it. Before considering some of the interrelated processes by which nature provides the essentials that are needed for man's survival, it would be well to give thought to the amazing increase in human numbers, especially within recent centuries.

* * *

In the misty cons of the past, when the human species had only a tenuous hold on life, the number of people in any given region must have been very limited. Through millennia of time the earth's human population increased but slowly. 'Making a living' in a hunting or pastoral community was a difficult business. Actually, there are no reliable data as to the total world population even throughout most of recorded history. In the early part of the seventeenth-century, however, enough figures were gathered together from every continent and every country to provide a fairly reliable estimate of the earth's total human population. This 'world census' indicated that the total number somewhat exceeded 400,000,000. In the year 1630, then, one could, for the first time, have some idea as to how many 'neighbours' there were on the planet. That, one might say, was 'just the other day'—only

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twelve generations ago, or merely four human lifetimes. It is not likely that the earth's population had previously been greater—a slow increase seeming to have occurred through tens of thousands of years, checked here and there by famines or pestilences, finally reaching this figure of upwards of 400,000,000 people. For another two centuries there was a steady increase so that by the year 1830 the total world population had doubled.

Then came the violent explosive upsurge in human numbers. By the year 1900, or within three generations, the world population doubled again, touching the figure of one billion six hundred million persons. By 1940 the figure rose well over the two billion mark and is still steadily increasing. The rate of increase is now approximately 1 per cent per year. If this rate were to be continued, it would mean a doubling of the present world population in about seventy years. Obviously changing conditions in many countries will affect the rates of increase within the next few decades, yet students of population point out that by the end of this century there may be still another half-billion people on the earth and that the world population in a hundred years may considerably exceed the three billion mark.

These computations are in effect an extension of existing population trends in most of the countries of the world. It is not the affair of such experts to tell us how so great a number of people are going to be fed or how they are to receive enough of the other basic resources of the earth to support life, especially in view of the fact that hundreds of millions of people today are undernourished and otherwise lacking in the basic requirements of existence that alone can be provided

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by the earth's fertility. What a prospect! Of course, as we all know, these are momentous days and many things can happen to check population growth, even including the devastating use of atomic bombs in a new war. It is difficult to adjust one's mind to the possibility that the present negotiations between nations could fail to prevent such a savage denial of the right of human existence, and that the problem of the pressure of increasing populations—perhaps the greatest problem facing humanity today—cannot be solved in a way that is consistent with the ideals of humanity. There is an ironical twist to the fact that population pressures have long been recognized as one of the major causes of war. On the other hand, there is as yet scarcely any recognition of the self-evident fact that such pressures are the major cause of the world-wide depletion of the natural living resources of the earth. To put it somewhat differently, most people still have the notion that the living resources of the earth are illimitable and that they can be drawn upon as if there were an endless reserve. How naïve and typical the remark of a capable American businessman recently, when his attention was called to the fact that the forests of his country were being rapidly exhausted—'Oh well, we don't need to worry because if we use up our forests, we can get all the timber we want from Mexico.' Let him go to Mexico and see what is happening there.

To retrace our steps for a moment—the causes for the explosive increase in population within the last two centuries are obviously due to new discoveries that have made it possible for man to exploit far more effectively than he could previously the living natural resources of all of the continents of the earth and trans-

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port them readily from one part of the globe to another. There is a discernible rhythm between the accelerated tempo of trade and the accelerated tempo of human reproduction. Shades of Dr. Malthus! He was not so far wrong when he postulated that the increase in population tends to exceed the ability of the earth to support it, and that while food production might increase in arithmetical ratio, population tended to increase in geometrical ratio. There were several developments that the gloomy doctor did not foresee, among them the exploitation of the Western Hemisphere, especially the United States and Canada. Further, he did not anticipate the development of means of transportation such as the creation of the great systems of steamship lines and railroads, and now even air lines. Above all, he did not envisage the invention of the internal combustion engine which has so incredibly accelerated the capacity to exploit the earth's resources of forests and croplands. This invention has brought its innumerable benefits and wrought its irreparable damage.

In passing, it should be observed that the industrial revolution in Europe, with its accompanying tremendous increase in population, was to a very considerable degree supported and fed by the United States and Canada, whose land resources were hastily developed and prodigally expended to help meet the pressing demands of a population that increased from 175,000,000 to almost 400,000,000 in a little more than a century.

We have now arrived at the day when the books should be balanced. But can they be? The once apparently inexhaustible natural assets of this continent are now little more than sufficient to support its own

increasing population, and the reserves in lands in the far corners of the earth are being drained through misuse.

If the total land area of the earth, amounting to somewhat more than 50,000,000 square miles, were divided by the earth's total population, we should find there is an average density of slightly more than 40 people to every square mile. This computation does not allow for the fact that only about one-half of the lands of the earth are *habitable* and, like most statistics, has relatively little meaning except that it leads one to a closer study of the distribution of people over the surface of the earth. Such a study reveals certain startling conditions, perhaps the most extraordinary of which is that more than one-half of all the people on the earth live on one-twentieth of the total land area, or at an average density of 400 people to the square mile. Another one-quarter of the earth's people live on an additional 13 per cent of the whole land area or at a density of about 86 people per square mile.

A somewhat different approach to this matter of the distribution of peoples, with an eye to where the principal concentrations occur, reveals the fact that there are three great clusters of humanity in three comparatively small regions of particularly favourable environment. One is the populous region of Europe, together with western Russia, bounded on the north by a line running just above Stockholm and through Leningrad, bounded on the east by the Ural Mountains, on the south-east by the Caspian and Persian Deserts and on the south by the Sahara Arabian Desert. This region contains more than 500,000,000 inhabitants who live on less than 3,000,000 square miles of land. In the Far East there are two great clusters of humanity. The

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larger of these is in an area that includes most of Manchuria, China as far south as Tonking, and Japan. Here there are approximately the same number of people on an area of less than 1,750,000 square miles. The third great cluster occurs in India and Ceylon, between the Thar Desert and the eastern edge of Bengal, where some 400,000,000 people are living, or starving, on about 1,000,000 square miles of land. Thus it is that in these three relatively limited regions of the Old World, aggregating less than one-eighth of the earth's total land area, there are crowded together two-thirds of the people of the earth. Incidentally, this means a density of about 400 people to each square mile, a figure eight times that of the density of the United States.

At first glance it would appear that the remaining 700,000,000 individuals must be comfortably off as far as living space is concerned. But it must be recalled that of the remaining land areas of the earth considerably more than half are too dry or too cold or too mountainous to be habitable, and that the habitable regions are those that lie in the Western Hemisphere, in Africa, in Australia or in some of the larger islands such as the British Isles or Java. Both the latter are now filled to overflowing, with densities running up to 700 people per square mile and populations, when added together, that approach the 100,000,000 mark—a fifth of the earth's total population only twelve generations ago!

Most of the remaining 600,000,000 of the earth's people, then, live in the Americas, or in Africa, or in Australia. Descriptions of how they are faring and what they are doing with nature's resources of forests, soils and water sources will be found in subsequent

pages. These descriptions speak for themselves. They refute the idea that the three great clusters of humanity in the Old World, admittedly too large to be supported by the productive capacity of the lands in which they live, can draw indefinitely upon the richness of these newer regions that civilization has entered only within recent centuries.

In passing, it should be noted that the extraordinary concentration of approximately half of the people of the earth into urban centres belies the argument frequently heard to the effect that there are plenty of the earth's products to go around and that the shortages that are suffered are due to the absence of efficient methods of distribution. It is apparent that the present means of conveying the earth's products from the regions where they are produced to the centres where they are consumed must, as matters now stand, be to a high degree skilful and efficient or a large proportion of the people of the earth could not continue to live at all.

There are those who believe that there are great possibilities of gaining additional subsistence from the earth through the *development* of the tropical areas of Africa and of the Amazon basin, where for obvious reasons there are as yet relatively limited human populations. One is inclined to say, 'Who wants to live there?' While it must be granted that there are such possibilities and that ways and means may be discovered of making these areas more or less productive, the fact remains that these tropical regions do not lend themselves readily to cultivation, to say nothing of habitation, because of their excessive heat and torrential rains. The conversion of these tropical regions to agricultural productivity could not be accomplished except at prodigious cost. Further, it is only pressure

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of the most extreme kind that will make people move from one land to another.

Probably the most cogent answer to those who look to the development of these areas for partial relief from the dire want now afflicting great numbers of people is to point out that such a development would at best prove merely of temporary usefulness and would be a stopgap and not a cure. No real solution can be found until there is a complete revolution in man's point of view towards the earth's resources and towards the methods that he employs in drawing upon them. Are we not, too, leaning upon the frail reed of wishful expectancy in the face of the constantly growing pressures of increasing populations in every continent of the world?

IV

LIFE BEGETS LIFE

All the component parts in the machinery of nature are dependent one upon the other. Remove any essential part and the machine breaks down. This is a primary fact and there is no other comparable to it in importance. This fact was known to some of the ancients and has been recognized periodically by certain civilizations, but through most of man's history it has been totally disregarded. It is the cardinal principle in the recently developed science known as 'conservation'. This interdependence of elements is, in truth, the basic law of nature. Therefore, unless man respects it, nature will not work for him.

Consequently all the productive elements of nature have to be thought of in the relationship of one to another. As far as the habitable and cultivable portions of the earth's surface are concerned, there are four major elements that make possible not only our life but, to a large degree, the industrial economy upon which civilization rests:

Water

Soil

Plant life, from bacteria to forests

Animal life, from protozoa to mammals.

The last two of these elements, being alive and capable of reproduction, are referred to by conservationists as 'renewable resources'. As a matter of fact, productive soil—namely, that which can be used to

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produce things that man needs—can also be thought of as being alive in that it harbours an infinite quantity of minute living forms of plant life known as bacteria and of minute animals known as protozoa. Without these soil becomes dead and barren. In view of the fact that all truly productive soil, known as topsoil, is the result of the intricate relationship of living things, and of the remains of living things provided by the processes of nature, together with delicately balanced mineral elements, it is not practicable for man to *make* productive soil, except experimentally and in limited degrees. Fertilizers are supplements and no more. They merely aid in restoring certain elements to depleted soils.

Water is of course the element that makes life possible to all the others. The function of water in the life scheme is so obvious and so well understood that it would be superfluous to elaborate the fact of its essentiality. Vegetation is composed mostly of water; more than 70 per cent of our own human body weight is water. Consequently, water must be generally available, and at all seasons, in habitable areas. Vegetation of all kinds, from trees to tomatoes, must have it regularly and adequately; animal life, including human beings, must similarly be able to depend on it, in season and out.

It was stated a moment ago that if one of the essential parts of the machinery of nature is removed, the machine breaks down. Regular and adequate water supply is dependent upon the preservation of extensive forests, especially in the watershed areas where streams and rivers have their sources. Water supply is also dependent upon vegetation cover in open country. When these natural conditions are too greatly disturbed, water supply diminishes or disappears. Springs

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dry up owing to the lowering of the underground water table. Further, rains falling upon exposed lands, which have been improperly stripped of forest or other vegetation cover, are not held in the soils and consequently rush to stream or river beds so that violent fluctuations of drought and flood conditions are started, becoming cumulatively more severe.

One element, perhaps the most vital of all, in this brief summarization of nature's economy is productive soil. This is the medium or resource upon which all life on this earth depends. *When that goes we go with it.* The surface of all the habitable or cultivable areas of the earth is, or rather, in its natural state, *was* covered with a layer of productive topsoil. This covering varies considerably in thickness, but the average thickness over the earth as a whole is computed to be not more than one foot, and probably is less. In the United States, for example, topsoil is estimated to lie originally at an average depth of about seven or eight inches over the face of the land. This, let it be repeated, is the principal feeding zone of the plants, which provide food for human or livestock consumption, fibre for clothing, and timber for housing and innumerable industrial uses. As nearly as can be ascertained, it takes nature, under the most favourable conditions, including a good cover of trees, grass or other protective vegetation, anywhere from 300 to 1,000 years or more to build a single inch of topsoil.

Yet what may have taken a thousand years to build can be, and in places has been, removed by erosion in a year or even in a single day. Wherever nature's balance is too greatly disturbed, accelerated erosion occurs, and man is continually upsetting the balance of nature, because of what he considers his immediate

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need, not looking even a few years into the future; or because of ignorance or greed.

The sinister pattern of erosion is the same the world over. It does not ordinarily occur without man's interference with the natural order of the landscape. Occasionally it does occur naturally, however, as in certain parts of the earth where natural desert conditions have existed since prehistoric times. But taking the world as a whole, before the advent of man the balance was maintained, and what soil was lost naturally in one place was compensated for by new topsoil constantly being formed from the materials beneath.

Erosion comes about through the exposure of land by wrong use or by overuse, by the careless removal of its protecting cover of grass or forests, or by denying it the constant water supply which it must have for the growth of protective vegetation. Any or all of these practices expose the topsoil, so that it can be blown away by winds or washed away by rainstorms. Thus land is often gullied into useless badlands that may be and frequently are impossible to restore. Many of us have seen swollen rivers, brown with silt—the valuable topsoil of some higher region being carried out to sea. Most of us have seen gullies cut by sudden storms or gradually formed by repeated rains. Everyone will recall the shock that came to the people of America in 1934. In that year a vast transcontinental dust-laden windstorm, darkening the sun, broadcast the fact that large once-fertile portions of five western states—Kansas, Texas, Oklahoma, Colorado and New Mexico—had become a desolate dust bowl. This catastrophe was the result of overgrazing by too large herds of cattle and sheep and of ploughing for crops grasslands that should never have been converted to this use. We, or

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the great majority of us, have forgotten that incident. Tens of thousands of people have not. They are the ones who have found it impossible to restore their lands or who have been unable to cope with the laborious and costly job of reclamation.

Perhaps the most widespread and certainly the most insidious sort of erosion is called sheet erosion, which, as its name implies, is the more or less even removal of soil in thin layers, a little at a time, by the steady action of wind or water. Often it results from the gradual movement of soil material from higher land to lower. Inconspicuous in its immediate consequences, it is a type of erosion most difficult to guard against.

A curious thing about erosion is the sorting action of the wind or water which carries soil away. Both wind and water bear with them for great distances the life-giving organic matter in the soil and the finer, richer grains of mineral soils, but they drop behind them the relatively worthless heavier sand and bits of rock. Streams and rivers usually deposit the organic matter and other finer material well out to sea, where it can no longer be of use, and wind at almost stratospheric levels may carry fine dust halfway around the globe, or even further. When this dust finally settles, much of it too falls into the sea.

It would be hard to enumerate all the many causes of man-made erosion throughout the world, though the sequence of events has much the same aspect wherever it may be found. To produce food man makes clearings in forests or, in areas of natural grassland, turns the protective sod for planting. He plants his grain or other crops one year, and then the next year, and then the next, too often leaving his fields bare and unprotected from the elements in the stormy seasons between har-

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vests. In flat country the processes of erosion are less apparent though still present. On sloping lands, comprising the great majority of the earth's cultivable areas, erosion is active and eventually fatal unless man controls it, which he too rarely does. As man's yield of food from a field dwindles with each harvest, he looks about for a new place to plant, leaving the old one to the fate that erosion will complete. Proper agricultural methods, now well understood, are capable of preventing this destructive cycle of events. Yet over great areas of the earth, man, until recently, still moved from place to place, wearing out the land without a thought save for his immediate physical needs, or because of a desire for quick profits to be robbed from the soil that might have served him permanently. The day when new fresh lands can be found is now almost over.

Another cause of erosion is overgrazing of grasslands, where herdsmen try to maintain the largest possible number of animals on a limited range, grazing at all times, seasonable and unseasonable, and so destroy the grass and bushes to such an extent that nothing is left but nearly barren ground. Such abused land soon becomes gullied by the rains or suffers sheet erosion, or is subject to the more dramatic and terrible wasting by violent winds and torrential rains.

The indiscriminate cutting down or burning of forests is one of the most widespread causes of erosion. Too close lumbering, especially on sloping lands, is nearly as damaging as the forest fires which we all have come to dread. When the forest is down, the land that was once protected by it suffers from *flash runoffs* of the water whenever there is a heavy rainfall. As the water is not held on the surface long enough to percolate slowly into the ground, to emerge later in the form

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of springs, there is at times too much water running off into the streams and at other times not enough, hurting the land both ways, causing lowered water tables in a whole region, and resulting in either flood or drought conditions, often over very wide areas. Reservoirs become clogged with silt as a result of soil washing down from slopes once protected by forests, so that they are able to hold and distribute less and less water. As a consequence they provide less flood control, less water supply, less power, and can serve only a fraction of the lower land they were built to nourish.

There is another major cause of loss of the interdependent resources of forests and soils. In a way it is one of the crowning ironies of human life today. This is the warfare of man with himself. The urgency of demand for forest products during the war just ended has accelerated the destruction of fast-vanishing forest reserves in many countries, while the pressures upon agriculture for high-speed crop production have been so great that they have led to the *mining* of croplands for quick returns rather than encouraging their orderly use. The after-effects will be felt for decades, and in many areas the loss will be irreparable due to denudation through erosion that follows the stripping of forest covers and the misuse of agricultural lands.

While there are other lesser reasons for the loss of these living resources of forests and productive soils, the above will indicate some of the major disbalance of our civilization with nature upon which the sources of our life depend.

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As to animal life, how can one write of it merely from the functional point of view? The mind pauses,

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sensing once again the images or sounds that memory summons—the flash of flight or a song from the heart of a woodland, the quick movements of the small and furry one preoccupied with harvest, the swirl in the placid water at the bend of the stream, the call from the air at dusk of those journeying southward, the silhouette of the lone creature with curled horns beneath the mountain peak. More remote, in the farthest waters of the earth, are vast forms, in bulk and weight equal to twelve bull elephants, warm-blooded, suckling their young in the cold reaches of subarctic seas. Once their ancestors lived on land, but that's another story. And equally remote, yet near at hand, are the tiny things. How can we conjure the secrets of their lives? If we pause, incredulous, at the thought of the beauty, infinite variety, and mystery of animal life, we still are faced with the enigma of its motivations. The statement, quoted earlier: 'There is no intelligence in which some traces of instinct are not to be discovered, more especially no instinct that is not surrounded within a fringe of intelligence. . . .' provides a clue, and yet to what degree can it explain the actions of animals whether their position in the scale of life is what we term *high* or *low*?

The *higher* ones seem closer to our understanding, doubtless because they, especially the mammals, have patterns of life similar in many respect to our own. Perhaps, then, in this matter of motives and action we should face the enigma of one of the 'lowliest of the low', of a small beetle, for example, known as *Sitaris*. Its problem is the common one of how best to get one's young started in life, which *Sitaris* has answered by laying its eggs at the entrance of an underground passage dug by a species of bee known as *Anthophorus*.

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The egg hatches into a larva which, after due time, attaches itself to a male bee as it goes out of the passage, clinging to it until the 'nuptial flight' when the larva opportunely leaves the male and attaches itself to the female bee, remaining with her until she lays her eggs. It then removes itself to one of the eggs, which serves as a support for it on the honey in the bee's nest, devours the egg within a few days, and, resting on the empty shell as if upon a skiff, undergoes its first metamorphosis. Well provided for now, it floats upon the honey, consuming it for nourishment, and soon becomes a nymph and finally a perfect insect. What impulse causes the parent *Sitaris* to lay her eggs at the entrance door so that the young may in turn . . . and in turn . . . and in turn . . .? But why conjecture? There are countless other examples of impulses and actions among the lowly and higher forms of animals similarly beyond our comprehension.

How do we happen to delude ourselves that certain *inventions* or accomplishments are man's alone? Radar, direction finding either by supersonics or, as is now suspected, by electromagnetic waves, long non-stop flights, dives to great ocean depths, feats of engineering—man is not the first to achieve these things. They have been developed and practised by various kinds of animals during countless millennia, even before man appeared upon the earth. This fact is not cited as a humbling thought, nor in denial of the obvious and complete supremacy of the human mind. It is merely a truth that symbolizes a relationship between man and other living things. In its own fashion it bespeaks the unity of all life.

An animal, whether mammal, bird, reptile, fish or insect, is not merely the form that the eye looks upon.

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It is a fractional yet dynamic expression of the processes of nature, evolved through immeasurable periods of time, related to many other living things, as they are to it. It is part of a theme, old, yet new and invisibly changing. It is no more the chain than is the link; it is no more the tree than is the leaf.

With such thoughts in mind it is difficult to bring oneself to speak of animal life merely from the point of view of its utility or, let us say, of its functional contributions to the fertility of the earth. Yet, while based on the belief that all kinds of wild living things are a joy to the eye, as well as fascinating subjects to study, and that it is wrong wantonly to destroy them, this book is not written primarily for any aesthetic or ethical purpose. The matter can be resolved by recognizing that when killing of other creatures is done without an understanding of what they are contributing to the life scheme, man is contributing to his own life deterioration. Some of the killing that man does of other creatures is all right; it is close enough to the pattern of life as a whole—reasonably close enough, that is—to justify itself. But the rub comes when we kill without knowing enough about the after-effects. There is no risk in making the flat statement that in a world devoid of other living creatures, man himself would die. This fact—call it a theory if you will—is far more provable than the accepted theory of relativity. Involved in it is, in truth, another kind of principle of relativity—the relatedness of all living things.

As a somewhat extreme illustration, among many others, take that form of life that man likes the least—of which the unthinking person would at once say, 'Kill them all.' I mean insects. Of the extraordinary number of kinds of insects on the earth—about three-

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quarters of a million different species have already been identified—a small minority are harmful to man, such as the anopheles mosquito, lice, the tsetse fly, and crop-destroying insects. On the other hand, innumerable kinds are beneficent and useful. Fruit trees and many crops are dependent upon insect life for pollination or fertilization; soils are cultured and gain their productive qualities largely because of insect life. Human subsistence would, in fact, be imperilled were there no insects. On the other hand, insects, capable of incredibly rapid reproduction, have been freed by man himself of many natural controls such as those once provided by birds, now so diminished in numbers, or by fish, once a potent factor in insect control, no longer existing in countless lakes, rivers and streams now so polluted that aquatic life has disappeared. In attempting to find substitutes for natural controls man has resorted to the use of chemicals of increasing power. A few years ago arsenicals came into style—widely used in freeing fruit orchards of pests. So promising this method has seemed—but insidiously it sometimes results in destroying insect-eating birds; and after several seasons the ground itself, in many orchards, has become so impregnated with the poison that the trees are affected and their fruit-bearing capacity dwindles. More recently a powerful chemical known as D.D.T. seems the cure-all. Some of the initial experiments with this insect killer have been withering to bird life as a result of birds eating the insects that have been impregnated with the chemical. The careless use of D.D.T. can also result in destroying fishes, frogs and toads, all of which live on insects. This new chemical is deadly to many kinds of insects—no doubt of that. But what of the ultimate and net result to the life

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scheme of the earth? On another front man is blindly in conflict with nature, too often overlooking the fact that the animal life of the earth, its inter-relationships, its preservation, are wrapped up directly with his own well-being. Will the day come when this is generally realized?

Here we come to a kind of paradox. It is apparent that many of the lower forms of animal life—ranging from protozoa up through the insects and other invertebrates even to the reptiles, fishes, birds and certain small mammals—play an essential part in the economy of nature. On the other hand, it is far from easy to prove that some of the higher orders or families of mammals are necessary to the life scheme of the earth, at least of this earth today, when human beings are so numerous and their demands for both space and subsistence so pressing. Among large mammals the ungulates, or hoofed animals, are much the most numerous, both in numbers of species and in numbers of individuals. Formerly, in primitive times, the ungulates comprised well over nine-tenths of the total large mammalian population in every continent except Australia and possibly South America. Another group of large mammals of higher order was that of the carnivores, or predatory animals, which functioned as a sort of control factor to excessive population increases of the ungulates. It is not likely that the carnivores exceed 1 per cent of the total large-mammal population. Further, there were the primates, living mainly in the tropical regions of Asia, Africa and the Western Hemisphere.

When we think, then, of the part played by the higher and larger mammals in the economy of nature we are considering principally the question of the

ungulates. In view of the fact that the forage needs of domestic hoofed animals are similar to those of their wild forebears, it is not surprising that domestic horses, cattle and sheep have largely pre-empted the grasslands and other regions once occupied by the great natural societies of hoofed animals such as the many species of deer, antelope, and wild cattle. Any attempt to gauge the effect that the substitution of domestic hoofed animals for their wild predecessors has had upon the earth's fertility would be no more than rank speculation because there is no accurate way of approaching the question and there are too many unknown inter-relationships that cannot be measured. A rather curious sidelight, however, is thrown on the subject by comparing the present number of domestic hoofed animals with the presumed number of their wild predecessors in North America. The figures issued by the governments of Canada and the United States for the years 1945 and 1946 respectively indicate that the total number of domestic horses, cattle and sheep in that continent was approximately 179,000,000 animals. When the white man first arrived he found a continent incomparably rich in great 'game' animals—bison, deer of various kinds, including elk and moose, antelope, wild sheep and goats and, to the north, great herds of caribou. Even an approximation of their numbers is most difficult. It so happens, however, that estimates of at least some reliability have been made of the original numbers of bison, better known as buffalo, owing to the fact that in the main they lived on the open plains and so could be more readily counted; further, they were slaughtered largely for their hides so that commercial records could be consulted. It is generally believed that their numbers ran

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to at least 50,000,000 animals and probably more. Incidentally, the buffalo were so reduced within the short span of a century that by the year 1905 there were less than 500 left alive in the United States. At that critical moment they were finally protected so that this fine species was saved from extinction. Today, in refuges such as the National Parks and other safeguarded areas, there exist approximately 6,000 of these animals.

It is a fair assumption that the combined numbers of animals of other species, including deer, elk, moose, sheep, goats and caribou, totalled approximately another 50,000,000, which would suggest that there were once at least 100,000,000 wild hoofed animals in these regions.

These figures concerning present domestic and formerly wild animal populations of this category tell us little that is of aid in determining whether the loss of such great numbers of wild animals has had any real effect upon the 'economy of nature' in the U.S.A. and Canada, except for one factor which, though of minor importance in itself, is of major importance in its broader implications. The matter can be approached by recognizing the general principle that the sustained richness and productivity of the earth depend upon there being returned to it the organic material that grows from it. This *order of nature* can be expressed by the symbol of a circle. Formerly all wild animal life was an inherent part of that organic circle. Our present domestic animals represent a minor portion of the organic whole that is not permitted to return to the earth of its origin. They end up in the consuming centres, their residues in disposal plants or carried to the ocean. The broader implications are that this holds

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true of a large proportion of the earth's products today—both animal life and plant life, including vast quantities of forest products. There is one steady movement of organic material to towns and great cities and industrial centres—there to be consumed or disposed of as waste but never to go back to the land of origin. We are hacking at the circle expressive of the organic unity and productive processes of nature. The question is, Will we one day actually break that circle?

The animals of the earth are dependent on man's sufferance now, and of late years conditions have improved for them. There is a growing public consciousness that whether or not we need them for utility's sake we must protect them. National Parks and refuges have been set aside for them in the States and in many countries. But civilization and the rising needs of increasing numbers of people are pressing hard upon the last remaining wildernesses. Man must live, but one wonders sometimes, in faraway moments, whether there is not a primal form of ethics involved. Should not man perhaps, even for his own peace of mind, think of himself not as the consumer alone but as the protector? Like companions of an earlier life, if we forget them they are gone forever. It is man's earth now. One wonders what obligations may accompany this infinite possession.

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Many people have the notion that lands that have been misused and that have become sterile can be restored to fertility by the use of chemicals. Nowadays we are so impressed by the 'marvels of modern science' that we are apt to consider it capable of any accomplishment—even of patching up nature. We move, live, and have our being in a world of gadgets and inventions. That is, about a billion of us do—the other billion live on the land trying to produce a subsistence for themselves and sufficient products of the land for the rest of us who live in towns and cities. It is realized of course—when one stops to think of it—that forests once destroyed take a long time to grow again, but it is likely to be forgotten that, for example, in some of the desolated countries around the Mediterranean the forests have never reappeared—nor could they, even with the most careful nurturing, within many, many lifetimes, because the land has been denuded of its soil. There is a general impression that all that is needed to make such land areas productive is to apply fertilizers. There could be no greater illusion.

The treatment of soil by chemicals and fertilizers is, it is true, of considerable help in preventing land from becoming sterile. Under existing methods of rapid crop production, the mineral elements that nourish plant growth are removed from the soil faster than they can be replaced by natural processes, and consequently

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fertilization of the soil with such chemicals as lime, phosphate and potash is an accepted practice in agriculture today. Further, the organic matter of which soils have been depleted can be restored in large measure by the application of animal manure or by means of so-called 'green manuring', which consists of ploughing leguminous plants and grasses into the surface. There can be no argument concerning the fact that manures and chemical fertilizers are necessary aids in maintaining soil fertility, but at best fertilizers are corrective supplements. In no sense should they, especially chemical fertilizers alone, be thought of as substitutes for the natural processes that account for the fertility of the earth. In the long run life cannot be supported, so far as our present knowledge goes, by artificial processes. The deterioration of the life-giving elements of the earth, that is proceeding at a constantly accelerating velocity, may be checked but cannot be cured by man-applied chemistry. As to the speed of this deterioration, it has recently been estimated that there has been a greater loss of productive soil in the last few decades than the accumulated loss in all previous time. While this is solely an estimate and cannot be substantiated by actual figures, it is nevertheless one made by able men who have attempted to present the case of erosion throughout the world with the greatest accuracy at their command.

There are two reasons why artificial processes, unless they are recognized as complements to natural processes, will fail to provide the solution to the present crisis. The first is concerned with the actual nature of productive soil. The second reason is a practical one and hinges upon the difficulty, if not impossibility, of instructing great numbers of people who work on the

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land regarding the extremely complicated techniques that need to be applied to produce even a reasonable degree of fertility by artificial methods.

As to the first reason, it is necessary to bear in mind that the body of the soil itself must be stable, in the sense that it becomes impracticable to maintain good soil conditions if land is in movement because of abnormally active processes of erosion by either wind or water. Consequently, the first problem under any circumstances continues to be the prevention of continuing erosion which, as we shall see, has already so greatly devastated so many areas on the earth where inadequate methods of agriculture were employed. Further, it is above all necessary to keep the fact in mind that fertile soil is *alive* in the sense that it harbours many different kinds of living organisms that function in relationship to one another and provide, in effect, the health and productivity of the soil itself. *Ingenious as man is he cannot create life.* Stated simply, soil is fertile largely because of the living organisms that are within it, in combination, of course, with its mineral nutrients. Nowhere on this earth has nature provided a more intricate pattern of inter-related life than in the soil. There is an immense variety of animal life, ranging in size and kind from burrowing rodents, insects, earthworms, down through the scale to animals and life forms of microscopic size such as protozoa and bacteria. These living things make two basic contributions to soil fertility, one as important as the other. The first is soil cultivation, including the letting in of air and water through the soil made by the passage of their bodies, whether large or small. In this job countless living things are at work—among them various kinds of insects and other invertebrates

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running in numbers to millions per acre. The earth-worm is the most familiar but by no means the most important of nature's soil farmers.

The second contribution comes through the fact that animal life and living bacteria are the media by which organic remains are mixed with the minerals in the soil. These living elements—innumerable hosts of them, invisible to the eye—are, in effect, the soil chemists. The scope and complexity of the work of the bacteria alone are almost beyond definition. Even a summary glance at some of their functions will illustrate the extremely complex nature of productive soil and the reasons why the successful application of man-made processes cannot effectively be substituted for the processes of nature. One of the activities, for example, of bacteria is gathering nitrogen from the air, combining it in forms which in turn can be made into protein by plants. Free nitrogen in the air cannot be used directly by plants, and it will be remembered that all living things—plant and animal—from virus to man, are essentially protein organisms. Another group of bacteria decomposes the protein existing in dead animal and plant materials in the soil and changes them to ammonia. Ammonia contains nitrogen, but most plants cannot use the ammonia as such since the nitrogen must be available in the form of nitrates. The transformation from ammonium salts to nitrates is brought about by two other groups of bacteria. The first group changes the ammonia to nitrites, which also are unusable by plants. But a second group of bacteria is standing by whose function is that of converting the nitrites to nitrates, in which form nitrogen is readily absorbed and used by the plants to build more protein, and proteins mean growth. The reverse

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process also takes place in that some bacteria change nitrates to nitrites and finally to free nitrogen, which goes back to the air. Here it is picked up by the nitrogen-gathering bacteria and again transformed by them into usable protein-building compounds.

There is an almost endless number of other characteristics of fertile soil. For instance, iron is a necessary element for living cells; no matter how minute the quantity, it is required for the growth and well-being of all plants and animals. In the complete absence of iron, green plants will fade to a yellow and finally die. If such a condition develops it may indicate a slow or improper bacterial activity of the soil. Certain soil bacteria are able to take up iron and accumulate it on the surface of their cells, where it is quickly changed to some more soluble form of iron compound, which is then taken up by the plants.

Another important constituent of living matter is phosphorus. This element is also tied up with proteins. The bony framework of man and animals consists largely of calcium phosphate. This material is insoluble, but despite this fact it is converted to a soluble form of phosphate by the action of soil bacteria, the solvent action being largely due to carbonic acid produced by these bacteria.

In addition to the four major chemicals of soil, namely nitrates, lime, phosphates and potash, there are a number of other essential elements such as copper, manganese, zinc and boron, known as 'minor' or 'trace' elements. It is only in recent years that the essential nature of these constituents has become known. Previously it was erroneously assumed that the amounts used by plants were too small to be important. There is no room for doubt that most of

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them, perhaps all of them, are vital to health and strength, even though they are supplied by nature in minute volume. The mere fact that they exist and appear to have a definite part in the life scheme emphasizes the extreme complexity of earth fertility. The relationship between land health and the health of human beings, as well as other animals, commented upon in subsequent pages, is actually no more than another aspect of the delicate and complex relationship of all life. How in the face of these things can we accept the idea that 'science' is capable of providing for the continuity of human life by substituting its methods for those of nature?

The second reason why undue reliance should not be placed upon soil chemistry to produce sufficient crops and fibres is purely a realistic one. In theory the answer might be found in that direction. In measuring the possibilities from a practical point of view, however, one would have to assume that workers on the land could be so instructed that they would be capable of putting into practice methods of agriculture that in themselves are extremely complicated and would be able to adopt techniques that are not even as yet fully developed. It is one matter to get fairly satisfactory results on an experimental farm—it is obviously quite another to hope for such results where millions of workers on the land are involved, many of them bound by unfavourable customs of land use, especially when we are speaking of large numbers of people in many parts of the earth who, unfortunately, are completely illiterate, so that education in highly technical methods of land use would have to be conducted by oral instruction or by visual demonstration—at best a formidable task.

Another recourse that is sometimes blandly pro-

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posed is the establishment of great central 'food factories' where edible plants shall be grown in solutions of chemicals and water. The culture of plants by this method, known as hydroponics, is not a new art, having been started in England in a crude way as long ago as the eighteenth century. In more recent times it has been used extensively by research workers in many countries as a tool to arrive at facts regarding the growth of plants. So far the production of plant growth on any large scale through this method has not been accomplished, and those who are conversant with its complexities strongly question its practicability. Also, there is a good deal of glib talk that we shall be able to derive a large proportion of our basic subsistence from marine resources, including plant life. Far be it from anyone to laugh off the time and effort which are being devoted to studying the possibilities of filling human needs by these expedients. Maybe the day will actually come when hard-pressed and diminishing human populations will be grateful for being able to fall back upon such resources. All life once came from the water and perhaps, who knows, we shall have to return to it for survival. But one can only wonder whether the proponents of such ideas have thought the situation through to its ultimate implications. Such theories of action would bring with them a social revolution of such magnitude that the whole structure of human society would be torn apart. People who live on the soil and produce their living from it constitute more than one-half the total earth population.

The issue might as well be clearly drawn. The problem is how to conserve the remaining good natural soils that exist on the earth, together with the complementary resources of forests, water sources and the

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myriads of beneficial forms of animal life. There is no other problem. If that is not solved the threat to human life will grow in intensity and the present conditions of starvation that are already apparent in various parts of the earth will seem as nothing in the years that lie ahead.

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The references made above to the intricate biological processes that are involved in the creation of fertile soil provide a clue to another relationship, that between the soil and the health of human beings as well as of all other animals that feed upon the earth's products. The old saying that 'a man is what he eats' is acquiring a considerably greater meaning than it had at the time the phrase was coined. Our energy and well-being, physical and even mental, are dependent in the main upon the composition and quality of our diet. All of it, except of course fish and other food taken from the ocean or inland waters, is derived from the soil, whether in the form of grains, fruits or vegetables, or in the form of meat and the milk of animals that in turn live upon plant life.

As will be seen in a moment, there is an extraordinary and altogether fascinating similarity between the body elements of animals, including human beings, and those of plants. Knowledge regarding this parallelism is of fairly recent origin. The relationship between health and the nutrients that come from the soil represents a new and highly complex field of scientific inquiry. While much has of late been learned, there are still innumerable opportunities for further work of high importance in the fields of biology and medicine.

In order to gain at least a general idea of this whole

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matter, it probably would be illuminating to consider a few facts concerning the chemistry of plants and animals as well as a miscellany of recent observations that support the belief that not only man's well-being but his actual survival is dependent upon the preservation of the *health* of the earth which today is already substantially impaired by the violent and blind treatment man is inflicting upon it.

We are, in truth, of the essence of the earth. Our bodies, as well as those of all other animals, are composed of chemical elements that are derived from the air, from water and from the soil. Long ago early thinkers sensed this unity as evidenced by the words in the Bible describing man as a handful of clay into which the Creator had blown the breath of life. For a long time, however, it was supposed that human beings and other animals were composed solely of four major chemical elements, all derived from the air or the water—namely, oxygen, carbon, hydrogen and nitrogen. There was excuse for this supposition because all but about 5 per cent of our bodies is actually made of these four elements. Subsequently, as the science of chemistry slowly developed and the composition of living bodies came under closer scrutiny, other elements were found to be present. During the last century it became generally recognized that calcium, phosphorus and potassium were present in both plants and animals. This led to the false assumption that if these elements, or their compounds, together with compounds of nitrogen, were placed in the soil in generous quantities neither plants nor animals would suffer from malnutrition. Beliefs that merely express partial truths sometimes survive too long, and it is amazing how much damage they can cause. For many

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decades, in fact for the better part of a century, this analysis was accepted as telling the whole story, and dominated the teaching of soil chemistry until very recently. Worse than that, it gave rise to widespread and inadequate practices in agriculture that have become so ingrained that they are still persistently followed. Within limits these practices are, of course, distinctly helpful, but the point is they are based upon the erroneous assumption that the use of fertilizers containing nitrogen, phosphorus, potassium and calcium is sufficient to maintain the health of the land and consequently the health of animals and people that live upon its products.

Only in relatively recent years has science become aware of other elements in living bodies. These discoveries reveal the essential oneness of human and other animal life with the earth itself, or, more specifically, with good and fertile soil. Further, these discoveries suggest that human health is directly dependent on land health and that as the latter diminishes, so will the former, even to the vanishing point.

While it is true that the four major elements derived from air and water comprise about 95 per cent of the human body, and that calcium, phosphorus and potassium are of next importance as far as volume is concerned, the significance of recent discoveries lies in the fact that there are a number of other elements, all derived from the soil, the absence of any one of which is bound to result in ill-health or even death. In this group of minor but vital elements are sodium, chlorine, sulphur, magnesium, iron, copper, manganese, iodine, cobalt and zinc, together with traces of other chemicals or minerals whose importance is not yet fully known. These elements total seventeen different kinds. All of

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them, with the exception of the first four derived from air or water, are demanded from the soil by animal life. Plants require all of these elements, with the exception of cobalt, sodium and chlorine, but in addition need at least one other, boron, that apparently is not required by animals. It should be noted, in passing, that these various elements are not present in the ordinary forms in which one is accustomed to seeing them but are found principally in the form of salts such as sulphates and nitrates, which, as indicated in the earlier part of this chapter, are miraculously created from the original minerals into assimilable form by the biological processes constantly taking place within the living soil itself. All of this makes it evident that the maintenance of soils of sufficient fertility to support life is a two-sided problem. It is a matter of preserving *quality* as well as *quantity*. There is more to this science of soil conservation than was realized even a decade or two ago.

It needs to be remembered all the while that there is a wide variation in the composition and quality of natural soils before ever they have been put to use by man, which accounts for the many and obvious differences in sizes, strength and health conditions of racial groups living in different parts of the earth or even in different regions of the same country—regions that are sometimes quite close together.

‘When is a vegetable not a vegetable?’ One needs to ask the question seriously these days because colour, form and bulk are not necessarily the only criteria by which we can tell whether vegetables, or any other earth products, contain nutrients essential to health. There is the obvious likelihood that if soils in which plants are grown have become leached, depleted, or

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otherwise impoverished, the food derived from them will be deficient in energy-giving or health-giving content. In recent years much work has been directed towards the effect of diet deficiencies on human beings. One investigation among many others was directed towards the study of different races of people in the quest for the cause of dental caries. This work was initiated on the hypothesis that tooth decay is caused principally by the *absence* of something rather than by the *presence* of something. The vast amount of accumulated data lends support to the hypothesis under which the work was undertaken. And yet, as matters stand today, research work has not progressed to a point where there is unanimity of opinion concerning this interesting and highly important subject.

One of the general observations regarding diet and human health is that man frequently gives evidence of being least well nourished where and when his food supply is most ample, and as a corollary primitive peoples, as a whole, show the fewest evidences of constitutional diseases except when they come into contact with civilization. A notable exception to this generalization is found in the case of primitive peoples living in many areas near the equator where high temperatures and torrential rains exert powerful chemical and physical reactions, the rains tending to carry calcium and other minerals essential to health down to levels where the plant roots cannot reach them. Recognition must be given to the fact that the treatment and transport of food consumed by urban people unquestionably injure its nutritive values. It has also been observed that many towns and cities are located in regions that were once covered by forests. As a result near-by market gardens that provide much of

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the food supplies of urban communities are located on podsol soils that are characterized by acidity and the depletion of important mineral compounds such as iron and aluminium.

A dramatic example of the relationship between land health and animal health is provided by the decline and rebuilding of the fortunes of one of the great thoroughbred racing and breeding stables in America within the last fifteen years. This establishment for decades had been one of the most consistently successful in the history of the American turf. The bloodlines of its stallions and of its blood mares had, over a long period of time, produced racing horses of unusual stamina and speed. Almost every horse that was started under its colours was home-bred on a large farm located in the heart of the Blue Grass country in Kentucky. Commencing with the year 1933 the fortunes of the enterprise, as to both racing and breeding results, began to dwindle. Each year fewer and fewer races were won despite the fact that some sixty thoroughbreds were maintained in training. Further, and even more alarming, breeding results began to decline, fewer mares each season came in foal, and mares began to drop stillborn or deformed colts. So bad did the situation become that during the entire year 1941, with some sixty brood mares to draw from, barely a race was won and breeding results were equally disappointing. The owner was told by various racing experts that it was apparent that the bloodlines of his stallions and mares had 'run out' and that there was nothing for him to do but dispose of his horses for the best prices he could get and start anew.

He could not bring himself to believe this. It so happened that his manager had studied at an agricultural

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college and had some familiarity with the matter of land and soil conditions. One day the latter came to the owner and told him that he had an idea that the trouble might perhaps be traced to the condition of their land. He suspected that the long use of the fields as horse pasturage, with constant cropping and perhaps the hardening of the ground by the hoofs of the horses, might be proving harmful. As a result of this conversation, plans were made at once for the study of the land by soil chemists and other agricultural experts. It was found that the soil had in fact slowly and insidiously lost its natural fertility. Analysis indicated that the soil was lacking in some of the chemical and mineral elements for which the land in this region was so well noted. It was observed that scarcely an earthworm was left on the entire property. A major programme of soil rebuilding was then undertaken. Cattle were introduced, manure was widely used, green crops were grown and ploughed under, and even, when the time was right, earthworms were reintroduced. Within two years the results on the track and in the breeding farm took a marked turn for the better. Improvement thereafter was consistent and rapid and by 1946 the stable was the third highest winner of races in the entire country and the breeding results had returned to their earlier excellent standard of mare fertility and sound colts.

One authority, chairman of the Department of Soils at the University of Missouri, has reached the conclusion, as a result of innumerable studies of farmlands in the Midwest, that soil fertility on an individual farm can be so depleted through failure to return manure, crop residues and other enriching elements as to change that farm within a single human generation

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from a place of good health to one of deficiency diseases for the farm animals and for the families that live upon it. He further observes that the same crops, still growing after decades of farming, may have gone over from protein-producing, mineral-supplying sustenance to vegetation mainly of fuel value and markedly lacking in the nutrients that are required to maintain health. The changes may occur without any diminution in the bulk of the crops or, in other words, the tonnage output of the farm. This deterioration to foods having in the main merely fuel value is aggravated still further by present-day processing methods which tend to retain the starches and sweets and to lose the natural minerals and vitamins. Another provocative observation from the same source is to the effect that the deterioration of soils is 'pushing domestic animals towards the dangerous precipice' until decreased reproduction, increased diseases, more body deformations and other irregularities are compelling early marketing of these animals.

It was a bright day when, through the growth of the science of bacteriology, the causes of communicable diseases became known. The marvellous progress of the medical sciences in discovering methods of coping with infectious diseases has in large measure removed the terrors of plagues and pestilences that once took such a heavy toll of human life. At the end of the last century it looked as if mankind were about to enter into a new era of health and happiness. It has not happened so. While the life span in many countries has increased, even in these there are evidences of a slow, silent, pervading deterioration of human health. There is a dearth of knowledge as to the time of commencement of this process of deterioration, assuming that such a

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process is in fact occurring. Medical records of a century or more ago can throw little light on the matter so that accurate comparisons with health standards in earlier times cannot be made. But that some change is now taking place is reflected by the appearance of a whole series of 'new' illnesses. As a group they are referred to as degenerative diseases, affecting many of the organs as well as the structural parts of the body, such as the heart, liver, teeth and bones. Their causes are little understood and consequently the medical profession is comparatively helpless in either preventing them or curing them. Imagine a country such as the United States, apparently rich in the fertility and abundance of its land resources, where the recent two-year study of the nation's health by the Senate's Subcommittee on Wartime Health and Education discloses that of more than 14,000,000 men examined for the draft only 2,000,000 were fully up to standard. A supplementary study indicates that approximately 12 per cent were found to be mentally unfit for military duty.

It would be a careless generalization to state that what appears to be the physical degeneration of people in America and elsewhere is being caused by nutritional deficiencies resulting from declining soil fertility. Civilization has brought with it many conditions of living that are anything but healthy. However, the supposition cannot be dismissed that the alarming increase of degenerative diseases, including psychological and neurological illnesses, may be related, in a manner yet to be defined, to the steady deterioration and wastage of topsoil, the precious sensitive earth cover through which life flows.

PART TWO

THE PLUNDERER

VI

ASIA: THEN AND NOW

Man's misuse of the land is very old, going back thousands of years even to the earliest periods of human history. It can be read in the despairing chronicle of ruins buried in sand, of rivers running in channels high above their surrounding landscapes, of ever-spreading deltas, of fallen terraces which once held productive fields or rich gardens. It can be seen in man-made deserts and in immense reaches of bare stone from which the once fertile soils have been washed and blown away. Occasionally in some wasted part of the earth a trace may be found of what was once there before the vast destruction. Perhaps there will be a terrace wall that did not fall away, but held its portion of soil where still are growing vines or olive trees that flourish in spite of the surrounding desolation, or a grove of ancient cedars in some protected place where all but their own small plot of land has been destroyed around them.

Erosion and its fatal consequences have often been attributed to a gradual change in the climate of a region or, more especially, to the fact that certain regions have, over long periods of time, suffered a marked diminishment in rainfall. Recent research does not, however, support the earlier theory that unfavourable trends in weather conditions can be held responsible. There are no real evidences of the geologic desiccation of a region, namely from natural causes,

within historic times. China, where many regions are severely wasted, has not been subjected to climatic changes of any moment for more than three thousand years. Palestine has today the same general weather conditions that it had in Biblical times. A small stand of cedars of Lebanon, untouched for many centuries because it was considered a sacred grove and was protected by a wall which kept out goats, supports the opinion that weather was not responsible for the loss of all the immense forests of cedar which existed within historic times. And in North Africa an olive grove, standing since Roman days, gives evidence that there too the weather cannot be solely blamed for dead cities buried under drifts of sand. Natural forces have played their part but man himself is intimately involved.

How did man become a land destroyer? It is easy to understand in present times, with the world so crowded and in need of food, how any overpopulated country, such as China or India, might deplete its land in a desperate effort to feed its crowding millions. It is difficult for people, under the urgency of immediate need, to take thought for the future of unborn generations, or of the earth that must support them. Indeed they have neither the time nor the strength nor generally the knowledge to do so; the best they can hope for is to keep alive, whatever the cost. But this was not always so. Once, as has already been told, man's numbers were limited, and up to historic times he had plenty of land to support him adequately without allowing that land to become depleted.

And yet, even in the earliest periods of history, man frequently suffered the feeling of being crowded, though the world population was but a small fraction

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of its present number. This sense of *crowdedness* arose from the concentration of people upon those lands which appeared most desirable and from a reluctance to strike out and develop new areas. Only under various kinds of pressure do people leave their home country. Even within recent times, and despite the ease of modern transportation and methods of communication, this reluctance of people to leave the place they are accustomed to is evident. The colonial empire that was Germany's prior to the First World War had all told a mere 24,000 or so German inhabitants, and Italy was never successful in placing more than 10,000 of her people in all her African colonies. The inclination of people to concentrate is age-old. It is one of the major causes for the long and consistent record of land damage by the human race and occurred throughout the earliest periods of human history.

How human beings first developed their methods and customs for gaining subsistence from the earth is largely a matter of conjecture. Cereals were probably cultivated in Asia as long ago as 8,000 B.C., and it appears that grains were grown in Turkestan and northern Persia before animals were domesticated.

One of the theories concerning the first domestication of animals holds that it was not done by the hunters or nomads but by the settled tillers of the soil and, at that, more or less by accident. Farmers seeing the seasons change around them, and the weather bring them good or bad crops, began to believe in beings beyond themselves who had control of natural forces. Thus they developed a religious sense connected with the natural world, and associated the wild animals of their own region with the gods controlling their destiny. The practice of propitiating various

deities by sacrificing to them appropriate animals did, it is true, spring up in many parts of the world. Since the animals were hard to come by, it is thought that farmers of long ago built stockades of fairly large dimensions, driving wild cattle and sheep into them yet not confining them so closely that they would not breed. So, in time, they were easy to take for religious purposes, and also gradually became used to people and thus domesticated.

All the while the earlier practice of living by the chase survived, which tended to divide early human societies into two groups, the hunters or nomads on the one hand and the tillers of the soil and townspeople on the other. After animals had become domesticated many of the former group took to the keeping of herds and flocks, moving from one grazing region to another and continuing the life of nomadism. There are many evidences of long-continued and bitter feuds between these groups throughout this period of history. These early feuds have their counterparts in other countries in subsequent times, as, for example, the dominance of the Mesta in Spain in the fifteenth century and the land-grabbing tactics of the cattle and sheep men in the United States at this very moment. At any period, whether then or now, the eventual result is inevitably the same—severe and frequently permanent damage to the fertility of the land.

In the region that lies between the Tigris and Euphrates Rivers there once was a land suggestive of the Garden of Eden, a rich land whose people lived well, built flourishing cities, established governments and developed the arts. Advanced methods of agriculture were developed including the building of a complex and extensive system of irrigation works

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during the reign of Hammurabi, about 2,000 B.C., by which the waters of the two great rivers were drawn off to increase the fertility of the land. Gradually great changes took place and the whole region deteriorated. This may have been because of the cutting of forests outside the cities, the exposing of land to eroding rains at certain seasons, and to the quick runoff which must always mean a dearth of water from natural sources later on. Also it may have been because of overgrazing on grasslands, which would have a similar effect. Eventually enemies seemed to have caused the final undoing through wrecking or blocking the ditches and canals which were the life streams of the settled populations. In this way they could plunder, graze in the fields and gardens and cut down trees for firewood, and in the end impoverish or destroy the people. These cities with all their elaborate civilization are today lost under the sand.

Near other early cities in western Asia the land had been heavily cultivated, and quite often terraced to conserve the soil which was the meat and bread of the people. Farmers had discovered—as it has now been discovered in many diverse parts of the world—that steep land from which trees have been cut down can still be preserved by terracing, and by putting back into the terraces all the animal and vegetable waste products available, and controlling the flow of water from level to level so that all parts of the terraced land would get their share. The famous hanging gardens of Babylon were probably terraced slopes. But it takes much labour to maintain terraces in a state of fertility, for where a terrace wall breaks, the wreckage of that relatively small area may be carried to lower fields, to break their supporting walls and continue the destruc-

tion downward in an ever-widening wedge of ruin. The much-used lands of the Babylonian civilization required many workers to keep them in shape. When town populations were partly killed off by nomadic invaders, there were not enough men left to carry on the perennial work of restoration and land care which alone would preserve fertility.

Much of what is sometimes called 'the cradle of civilization' gradually became a desert. Those who were left in the cities took desperate measures to keep alive, and even tried to adopt a nomadic form of life for themselves, but for this they were unfitted, and their numbers decreased until they died out entirely, leaving the empty ranges to nomads who could maintain themselves and their herds in what desert oases they could find.

The story continues in Syria, once a land of great richness. As the populations spread into Syria and toward the Mediterranean they moved into a wonderful country with forests and rivers offering a wealth of natural resources. In this region rich red-brown earth covered the limestone hills. More than a hundred cities sprang up in North Syria, their buildings making use of great beams of wood obtained from the forests, and of stone which they learned to handle with great skill. We know little about the past of these cities, but we do know that they prospered.

These cities demonstrate erosion at its worst. They are not buried under sand, but stand up starkly on their rock foundations, their doorways several feet above the foundation stones, showing that productive soil has been washed away from the very dooryards themselves. The limestone is there, but the red-brown soil has disappeared and cannot be seen at all except

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in small pockets where a wall has kept a little of it intact. In these pockets still grow the vines and olive trees that were once the glory of North Syria, the source of her prosperity. The remains of wine and oil presses abound in the region, cisterns among the ruins even now hold water, but there is no one here. The cities have been dead for a long time.

Yet this was the country that exported so much oil and wine to Italy that the discarded shards of the jars used for export form a hill to this day, the hill of Testaccio on the borders of the Tiber. The oil and wine were placed in huge pottery jars and transported by ship to Italy, there to be decanted into smaller containers. The large jars were evidently not thought worth sending back to the country of their origin, and so were broken up and piled to form a hill whose great size can testify to the extent of the trade in oil and wine.

And from the city of Byblos, on the North Syrian coast, went much timber to Egypt, the cedars of Lebanon sent down for the building of houses and temples in the Valley of the Nile. In the Syrian cities an elaborate system of terracing was developed to prevent land loss as the forests were cut and the rainfall became menacing, and for a long time the agriculture of the region was preserved. Indeed the earliest recorded reference to agricultural terracing is reported to be that found in an inscription of Thutmosis III on the wall of a temple at Karnak. This record states that wheat was grown on terraces at Arvad, not far from the Lebanon Mountains, in 1472 B.C.

But today the terraces are down and the cities are empty. Old Roman roads stand high above the land on which they were built; they are no longer level, as they

used to be, with the fertile floor of the plains, for there is no longer any fertile floor.

There were other causes for the disappearance of the civilization that had thrived in these once productive regions. It seems that there were well-established practices which led to the maintaining of a balance between what was taken from the land and what was returned to it. The cities grew in prosperity and artistic achievement from the third to the seventh century A.D. But peace was destroyed and their very life cut off by a Persian invasion in 614 and an Arabian conquest in 630. Here too there are evidences that the old feud played its part—that between the nomads with their cattle, sheep and goats, and the settled people on their land. Today all is desert which may never be restored.

In some of the regions of Central Asia it is believed there would be little drift sand were it not for the nomadic bands which for centuries have moved about irregularly, pitching their tents where they could find grass and browse for their animals, and denuding the slopes by cutting down shrubs and trees for firewood. The Soviet Government is now making an attempt to settle these people in permanent areas and to control their grazing practices. It is at any rate aware of the danger of letting them wander where they choose with flocks and herds in numbers so great that the land is threatened wherever they go.

Irrespective of what has happened in the past, the problem of many of the peoples in eastern Asia today is the most acute that faces any people in any area of the earth. In China live a people many of whom are gifted in agriculture and skilful in maintaining terraces and other good land practices, yet they have come up

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against an enemy within their own gates—that of overpopulation. The needs of teeming millions are being met at the expense of the future of the land. Hunger here is the constant enemy. Land was often very well used, but in many regions it has been consumed by the demands that have been placed upon it. We cannot tell what was the nature of the countryside that once surrounded the Yellow River of China. Today it is nearly all eroded desolation. The Yellow River, its channel built up by silt carried from the eroded lands at its sources, flows between high embankments at a level well above the surrounding land, and threatens and indeed often floods and destroys vast areas of China. So numerous are the people that when disasters occur and numbers of lives are lost the world is scarcely aware of it. Losses are soon made up and the pressure of people increases daily, and as this happens the physical strength of the race inevitably declines. What can these people do? This is one of the great unanswered questions of today, yet it is symptomatic of the problem that will face many another nation in the future if present conditions continue.

India is no better, in fact is in some ways worse off. The internal enemy here is the same—too many people for the land to support. India's land has long ago been depleted, yet her population continues to increase. Times of famine have reached almost cyclic regularity; scarcely anyone in India has enough to eat, and all the care spent on restoring a rich but wasted land goes for little, so long as there are too many people to live upon what the land can provide. A recent observer serving with the Royal Army Medical Corps in World War II attempted a detached point of view on what he saw in Calcutta in 1943 and 1944. To him it appeared that in

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that city the dogs had the best time of it. They could and did eat human flesh before city authorities could carry away the bodies of those who died of famine in the city streets. They fought with relatives of the dead for possession of the bodies. In Calcutta at that time if you stood in well with the authorities your yard might just happen to be kept free of corpses. But in another part of the city a single bag of rice was one day distributed from a relief station, doled out by handfuls to thousands of people, not so much with the idea that it could save them from death by starvation as in the hope that since they were so far gone they would die conveniently near the relief station, so that their bodies might be gathered up with a minimum of effort.

India's wasted land will not support such a pressure of population, but the immoderate increase goes on, weakening lands and people, rendering them helpless in the struggle to keep alive upon the earth. Here is the extreme present-day example of man, ever increasing in numbers, ruining himself and the earth on which and by which he must live.

VII

MEDITERRANEAN LANDS AND AFRICA

The Asiatic picture is so unfavourable, and the situation of many Asiatic peoples so desperate, that it would be a happy contrast if one might turn to the Mediterranean basin and the lands that surround it, and find there a region of plenty.

Once it *was* a region of plenty. In ancient Greece, with its forested hills, ample water supply and productive soils, civilization reached one of the highest moments in the history of human life. Although the people of Greece had slaves, an arrangement our present conception of society does not tolerate, yet the slaves, together with those they served, were well fed, well clothed and well housed. As happens in all balanced human societies, the arts flourished, and religion and philosophy supported and adorned the life of the people. Beautiful cities were built, and great men had their opportunity in a creative atmosphere that lasted for several centuries.

Twenty centuries have passed and great changes have been wrought upon that once beautiful peninsula. A recent incident suggests an appraisal of the present situation of the Greek people as influenced by their land situation today and, in turn, an inquiry into the possible bearing that this relationship between a people and their land may have upon current world affairs.

The United States recently made a loan of several

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hundred million dollars to Greece, with the avowed purpose of holding that country in line with the Western democracies rather than allowing it to fall under the influence or control of the Soviet ideology emanating from the East. Although the transfer of this large amount of money was called a loan, presumably it was not expected that it would be repaid in dollars, as Greece is an impoverished country, with only remote possibilities of an improving economy. Stripped to its essentials the loan is made for a social or political purpose. The transaction implies that the people of the United States, who put up the money, have grounds for belief that Greece as a nation is a 'going concern' or can become so with financial assistance, and thus become sufficiently stable to provide itself with a well-established democratic form of government. Is it not time to recognize that there can be no political stability if the basic subsistence needs of a people are not satisfied? These essential needs cannot be available if the productive land base is inadequate, failing or desolated. The mind tenacity of a people is weakened if their land is not sufficiently fertile to give them reasonable security, mental as well as physical, which in truth are indivisible. Otherwise, pressed by hardship, their purpose will waver as a reed in the wind.

This is said neither in detraction nor in criticism of the Greek people, who, as all the world knows, have borne innumerable hardships and have bravely attempted to retain the freedom that was first expressed by their great philosophers in the early days of glory of their country. Nor is it a comment upon either the strategy or the timeliness of making such a loan from a solely political point of view. The question comes down to this. Was the loan made with an ade-

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quate consideration of the land situation in Greece, and were arrangements concluded for a thorough long-term programme to build up the land base from which the living resources of that country are derived? If no such programme is put into effect, this investment, perhaps a precursor of other similar ones, is speculative in the extreme, and it is difficult to see how its purposes can be realized. These queryings and observations suggest that the time has come when international questions cannot be dealt with intelligently unless governments are prepared to recognize that the usage and condition of the land are essential elements in the world problem.

Even a cursory view of Greece gives one an idea of its desperate plight. It is a country with an area of slightly more than 50,000 square miles, about the size of the state of Arkansas, containing a population of more than 7,500,000 people. Not more than 20 per cent of the total land area lends itself to cultivation, which means that there is less than one cultivable acre for each inhabitant. It will be recalled that a minimum of two and one-half acres of cultivable land is computed as necessary to provide a minimum subsistence for one person. Every region of Greece, including its cultivable lands, is severely eroded. Probably not over 2 per cent of the entire country has its original topsoil, and this can be found only in those isolated regions that are still forested. Crops are now being grown on subsoils that still contain remnants of the fertile upper soil layers, or on virtually sterile subsoils. As a consequence, the average wheat production for the country as a whole is only $11\frac{1}{2}$ bushels per acre. A fair normal yield would be 25 to 30 bushels an acre, and really good cropland produces 50 bushels per acre. The nutri-

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tive value of crops grown on soils such as those still remaining in Greece is also conjectural.

Originally at least 60 per cent of the country was covered by fine forests. Now little more than 5 per cent is so covered. Centuries of cutting and burning and overgrazing by sheep and goats have brought desolation to the hillsides. Chaparral or brush covers most of the former timberlands. Practically all wood needed for shipbuilding and building materials, and even charcoal, is imported, a situation that has prevailed for several centuries. A recent observer of the land situation in Greece reports, in passing, that during all his travels through the mountain section of the country he saw only two pair of partridges and one rabbit—all the natural wild life having been killed off. He was struck by the complete absence of bird life, the only bird that was at all common being the raven, which was fairly abundant in some of the mountain valleys. In earlier censuses hunters were segregated as representing one of the principal occupations, an indication of the former abundance of wild life.

In normal times Greece is forced to import more than half of her bread cereals, three-quarters of the rice consumed, and smaller proportions of other basic foods. These are largely paid for by the export of tobacco, currants, wine and olives, which, with the exception of the tobacco crop, could be entirely used within the country if the people could afford to enjoy them. These facts are symptomatic of the low living standards to which the general population has been reduced. The deterioration of the land is still continuing. Marshlands are increasing because of the tremendous quantities of silt that are being carried to the lowlands from the upper watersheds. River beds of the

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main streams are constantly changing, swinging back and forth during the winter, getting out of their channels, destroying crops and injuring railroad lines. Engineers in the past have attempted to prevent this damage by confining the rivers between walls. Some of these old structures can be found a mile or two from the present channels. Serious erosion on slopes too steep to stand up under cultivation is characteristic of practically all of the mountainous regions. As a final straw, the extensive use for fuel of farm manure, in the absence of local timber, deprives the land of the organic matter that is so badly needed to maintain its fertility.

All the while the population has been increasing substantially. Even allowing for the fact that the territory of the country is larger than formerly as a result of various treaties that followed the wars in which Greece has been engaged, the present population represents a density of 154 persons per square mile, or five times that number in relationship to the cultivable areas. The needs of such a population could not be adequately met even on the most fertile of lands.

Despite all of this a constructive attitude is justified. Remedies could be applied that would improve these bleak conditions, not only to the extent of protecting the land from further denudation but also of gradually bringing back the land to some degree of its former fertility. A broad programme of reclamation, however, could only be accomplished with great patience, as years would pass before results were attained. The costs of such a programme would be very large. It would be necessary to convert the agricultural population to better methods of land use; large quantities of fertilizers, both organic and chemical, would be re-

quired; a long-term plan of reforestation would need to be instituted; storage reservoirs and irrigation projects would have to be built.

Several questions suggest themselves. To what degree did the United States government inform itself concerning the land conditions of Greece before arriving at a decision to provide that country with so substantial a fund? If these conditions did receive cognizance, what provisions were made for the initiation of a long-term programme of land-resource betterment? Apart from its political justification, if the loan was made in ignorance of these conditions or in unawareness of the relationship between land destitution and the political instability of a people, what of next year and years after? If the United States is to be godfather to Greece, or to any other country, can such a rôle be played with any promise of satisfaction to either party over a period of time unless the *godchild* can anticipate self-reliance as far as basic living resources are concerned? As will be seen in a later chapter the resources of America itself are slowly spiralling downward. The conception of godfatherhood may arise from an impulse of idealism, but only realism based on the facts in any given situation can justify a national policy involving the extension of aid to other countries. The concept of 'America can feed the world' is not for long. As far as the 'investment for democracy' in Greece is concerned, nature holds the trump card. In the final accounting the success or failure of this investment will depend on what happens to the land resources of this stricken peninsula.

Turkey, too, has suffered substantially from the destruction of its forests and the misuse of its croplands. The mountain slopes and broad valleys of

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European Turkey, lying across the Bosphorus north of Constantinople, are treeless. Here, in earlier days, were extensive forests and prospering farms. Now in this desolate region scattered herdsmen keep flocks that search out such pasture as this sparse land affords. Successive invasions of nomadic hordes have been a major cause of the injury this country has suffered. The province of Anatolia provides one of the most dramatic examples of erosion to be found anywhere in the world. Here the washing of the soil into the sea has choked all the harbours with silt, with the result that some former port cities, such as Tarsus, now lie ten miles inland. It is estimated that the mouth of the Menderes River has advanced seaward at the rate of about half a mile per century since the time of Christ. Around Istanbul the hills lie slashed and barren and the city streets are filled with beggars. Land misuse and poverty—nowhere is it more evident than in the Near East that these go hand in hand. Some years ago the present government set itself the task of improving methods of agriculture and of carrying out programmes of reforestation. It is too early to appraise the results of these efforts.

There has been so much said and written recently about Palestine that it seems superfluous to comment upon it here. That it was once largely a forested, fertile country is well known. Most of the formerly habitable areas are now in a ruinous state. It would be of the greatest interest to have the present political and social problems resolved if for no other reason than to indicate to what degree a concerted effort at land reclamation on a large scale could actually be successful.

Egypt—'the gift of the Nile'—is at a turning point. The great river, whose silt-laden waters have provided

both soil and moisture to this land, has its sources in Kenya, Uganda and Ethiopia far within Africa. For thousands of years the Egyptian people accepted a standard of living that was measured by the normal productivity of the soil carried to them by the river's annual floods. They had the security of a basic subsistence from nature—steady and to be counted upon since the earliest times of which there is record. But of late, even within the last century, two great changes are taking place, both of them unfavourable and threatening to the life of this country. The first of these has been caused by the growth of world competition as well as by the needs of an increasing population. The desire for national enrichment, the wish to gain profit from the soil, has led to the adoption of what are blindly thought of as more efficient techniques. All-year-round irrigation has been substituted for the so-called basin or floodtime irrigation, the secret of Egypt's fertility since long before the dynasties of the Rameses. This substitution was made in order to support the profit motive, namely the growing of cash crops such as cotton and tobacco for export. The needs of 'the Empire'! The factories in England! Let a historian—and an able one—measure the right and wrong, the long-time merit of all this. But now the land is groaning. The annual five-months' fallow, during which the essential fertility-preserving processes took place, has been abolished. The soil of Egypt is steadily deteriorating. Even the cotton yields are falling!

The second threat to Egypt is more insidious—barely perceptible from year to year yet steadily increasing. It is coming about through land misuse and forest destruction at the very sources of the Nile itself. A river is only a river insofar as the watersheds that

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give it birth are not unduly violated. In gauging the future of Egypt keep an eye on what is going on in Kenya, Uganda, and Ethiopia.

Great portions of North Africa, bordering the Mediterranean, used to be fertile, but are now desert. Wandering tribes of herdsmen move from oasis to oasis, their herds stripping such grass as there is from the gullied slopes, leaving nothing but the raw unstable soil. Here great cities lie buried under sand, ancient waterworks of immense ingenuity are still found usable where attempts have been made to reclaim the land. But this garden of the Roman Empire has nothing about it today to show that it was ever a garden, except scattered groves of olive trees, standing in places which miraculously escaped the general wastage and erosion. The exact age of the trees is unknown, but the waterworks which have helped to protect them date back to Roman times. Their healthy and productive condition today would indicate that adverse weather conditions have had little or nothing to do with the desolation which surrounds them.

In recent years the Italian Government made a new and experimental type of colony in the region of Cyrenaica west of Egypt, for it appeared that the desert still had its possibilities and might be reclaimed to support some of Italy's overflowing population. Roads, wells, and finally towns complete with public buildings were put up in the desert at government expense. Houses were furnished down to the last necessary item of equipment, food was put in the pantry, a garden plot laid out for each house, and livestock and feed provided so that each carefully chosen family group could start its life in the new land with every hope of success. On the whole the experiment

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was successful, and the colony was able to maintain itself and restore to productivity some of the desert land which was not too far wasted. Those who planned the experiment had sufficient foresight to avoid what might have been a major threat to the new communities: they succeeded in keeping the wandering Arab tribes from sweeping down and pillaging the new towns. They built wells and established towns for the Arabs, and made friends with them, improving their conditions so greatly that the Arabs had no need to turn to plunder for subsistence. But all this work involves but a minute area in a vast and almost useless eroded land, and serves to give some idea of the immense amount of work necessary to reclaim no more than a few square miles.

The Arab problem may indeed furnish the clue to what must have happened to transform the fringe of Africa lying along the Mediterranean from the granary of the Roman Empire into a land of dead cities buried under silt and sand, of desolate valleys below rock-topped hills from which the soil has been torn away. There is little vegetation left anywhere. Gullies of tremendous proportion have developed throughout the region that once helped to feed a great nation, and such valuable soils as remain continue to be swept sea-ward to create boggy marshes and infested swamp-land.

It was in all probability the advent of the Arabs with their flocks and herds that contributed to the devastation. The old controversy seems to have taken place here between the settled farmers and town dwellers, on the one hand, and their enemy the roving herdsmen on the other. As has happened over and over again in history, the nomads and herdsmen have called the last card. Their flocks have eaten the green

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from the land and laid it bare to rain and wind erosion. Gradually the great cities of a flourishing region were buried by silt and sand. Ancient Cuicul, a very rich town, was covered completely except for three feet of a column found standing up above the surrounding wrecked land; now, upon being excavated, it is seen to have had, in its good days, many fine temples and Christian churches, two forums, and storage facilities for great resources in grain and oil. And the city of Timgad, which was founded by Trajan in the first century A.D., suffered a like fate and was buried under wind-eroded debris so that nothing remained above ground of all its famous public buildings and magnificent houses but one part of an archway and three stark columns marking the site of the lost city, now merely a waste of wavelike mounds.

In Roman days this country was well cared for. It appears that the Phoenicians brought to it their skills in terracing and water control, which they had learned the hard way countless generations before, and taken with them wherever they went. Throughout North Africa may be found great numbers of cisterns and check dams of ancient origin. Many of these can be used today. In a number of places they are the sources of water supply for nomad tribes. But more important than the work of reclaiming this half-ruined land is the need to give the nomadic peoples some view of what their wasteful economy does to the earth, and how in the end it may cause their downfall as well as that of all living things in the region that they ruin. Whether such an idea could ever be made plain to the predatory tent dwellers is far from certain. Few are educated enough to understand the basic difficulties of the situation, and fewer still could or would act to prevent them.

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It would seem, at first glance, as if Central and South Africa must be a 'new' country with vast unexplored areas, capable of productive development. Actually this is far from the case. Land deterioration through erosion is widespread and great portions of the cultivable areas have already been considerably damaged. Africa illustrates perhaps more vividly than any other continent the ill effects of transplanting European cultures, and specifically European methods of using the land, to other regions of the earth, especially those lying in tropical or subtropical areas. What has happened in Africa confirms the axiom that methods of land use suitable to one social system or to one climate or region are not necessarily so elsewhere, and may, in fact, prove extremely harmful. Above all, Africa compels one to recognize the dire results of using the land to gain cash profits rather than as the source of basic subsistence.

Take it or leave it, nature gives no blank endorsement to the profit motive. For several thousand years it has won the argument on this point. How many times does this have to be proved to us? It might be justifiable for man to continue the argument indefinitely were it not for the fact that it is waged with mounting injury to people everywhere.

Before the arrival in Africa of European colonizers the native peoples had their own way of using the land. Approximately 120,000,000 people were living in an area almost four times that of the United States. Even allowing for the uninhabitable areas there was adequate room for the native peoples and they were not in the habit of taking more from the land than it could give, which is another way of saying that they gained their basic subsistence without thought of cash

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profit or of the wealth that might be gained through exporting land products. The methods of land use employed in various regions of Africa are well worth observing if only for the reason that they illustrate the ability of human beings to live on the land in what may be thought of as practically natural conditions. With the coming of European colonizers, two major changes took place: first, the native peoples were not infrequently forced from the fertile valley lands so that they were compelled to burn and cut forests in order to create clearings for their crops. While the pressure resulting from increasing numbers of people using the land has made itself felt, probably the most unfavourable recent development is resulting from the introduction by European colonizers of new crops such as cotton, coffee and tobacco, cultivated in order to bring cash returns through export. Naturally the native peoples in certain regions are quick to observe the ways of the colonizers and become interested on their own account in sharing in the returns. New desires are stimulated to acquire the kind of things that Europeans own that cost money, whether it be clothes or bicycles or just a bottle of gin. As a result, the natives are tempted to a greater and greater degree to mine the land for the cash that it will produce.

Another strong influence in hurting the land has been the system of taxation imposed by governing European powers. Often taxes imposed on native peoples amount to one-twelfth or even one-sixth of a man's total earning power. In Nyasaland, for instance, the native peoples were practically forced into tobacco culture in order to meet government taxation. The growing of crops for sale, which are almost without exception export products, obviously provides a

revenue to the controlling governments not only in tax money but in the value of raw materials exported. Taxation has been thought of as a most effective means of forcing the native out of his naturally contented state, a process that for some reason is considered necessary in attaining a condition of 'higher civilization'. From another angle taxation is used as a thin veneer to cover forced labour or economic slavery. One observer bitterly comments that every European influence, whether government, school, church, trader or rum-runner, pushes the African in the direction of money crops. The further the native is from the market, the more effective the tax plan is in forcing a change in the type of agricultural production. Native owners of cattle have not felt the squeeze so greatly and have had to make fewer adjustments, but they have been more heavily taxed because their wealth is more evident and more easily convertible into cash.

One should not be led to conclude that these trends and influences and conditions are by any means general, for the African by weight of numbers has held largely to his original customs and methods of land use. Agriculture is so much a part of the soil and the physical environment that it cannot be as easily displaced as can less basic activities. Consequently the production of food for man and beast in Africa, when one looks at the continent from a distance, still continues, in the main, to be by methods developed by the Bantu and other native races. Nevertheless, the pressure of these new and destructive influences is steadily spreading and the entire trend is towards an increasing destruction of the natural living resources of this great continent.

There has been, too, a widespread burning of forests in Central Africa to combat the tsetse fly, of which

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there are twenty-one known species. The bite of these flies has serious results, being responsible for the transmission of sleeping sickness in humans and many other trypanosome diseases in animals, including domestic cattle. Alarming reports have come from southern Rhodesia to the effect that more than 300,000 native wild animals have been deliberately destroyed in recent years on the grounds that they were carriers of the tsetse fly pest. This move on the part of the Rhodesian authorities, unfortunately being imitated in neighbouring territories, may well prove to be a misguided and futile butchering of the superb wild life of these regions. If this pest does not use game animals as a host, it presumably finds alternatives in other forms of animal life, including cattle or even smaller animals such as rodents. Not enough biological research has yet been done to justify a positive opinion on this matter, but this incident may well be just another unjustified and deplorable case of slaughter of wild life, and typical of man's lack of understanding of the place that wild living things occupy in the economy of nature.

In South Africa land deterioration is acute due to the harmful practice of burning the veldt to produce a quicker, but not a better, growth of grass in the spring, the widespread over-use of land for grazing purposes, the faulty location of crop farms on steeply sloping hillsides and the burning of manure to cook with instead of returning it to the soil as a fertilizer. The situation in South Africa, a country one-sixth as large as the United States, is epitomized in the terse observation made by its Prime Minister, Jan Smuts, to the effect that 'erosion is the biggest problem confronting the country, bigger than any politics'.

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There is a symbol other than a hammer and sickle that the Soviets could have adopted for Russia and its people. This other is a triangle, because within the boundaries of such a figure there lie virtually all the productive lands that are to be found in this vast country. The Russian people could not exist were it not for the *triangle*.

Russia is a country of contrasts. Despite its great size, climatic conditions impose severe limitations of one kind or another upon the productivity of the land. Consequently, as far as human use is concerned, Russia is far smaller than it looks on the map. It is of special interest today because of the drastic changes that the Soviet Government has made in the relationship of the people to their living natural resources.

Russia occupies one-sixth of the total land area of the earth. It is the largest country in the world with an unbroken territory and occupies most of the eastern half of Europe and the northern third of Asia. It spreads over an area of more than 8,000,000 square miles, from India to the Arctic, from the Baltic Sea to the narrow strait that divides Asia from North America. The sun takes eleven hours to pass over this vast country. When night falls over its western frontier, dawn is rising on the eastern frontier bordering the Bering Sea. These frontiers are as distant one from the other as Patagonia is from New York. It is sometimes

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forgotten, however, that Russia is a very northerly country. Almost all of the Soviet Union lies in latitudes north of that of the boundary line between the United States and Canada, and the Black and Caspian Seas at the southern border of Russia are in the same latitude as the Great Lakes in the United States. A long growing season and really temperate conditions occur only in the cotton and fig country of the southern oases, the citrus and tea-growing lands east of the Black Sea, and the rice lands of the Pacific Maritime Province, which combined are but a fractional part of the total land area.

Russia has, within its present boundaries, an estimated population of 195,000,000 people, or almost one-tenth of the earth's total. Its population today represents a figure almost double that at the beginning of this century, and is now increasing yearly at the rate of about $1\frac{1}{2}$ per cent.

Notwithstanding the vastness of this country, climatic conditions over a large part of it have much in common, variations occurring in the main along the borders of the Black Sea, the Caspian and in the far eastern portion of the country along the Pacific coast. Long winters obviously prevail. Strikingly enough, Russia as a whole enjoys very limited annual rainfalls. Millions of square miles are virtually nonproductive and therefore nonlivable because of too short a growing season or too little rainfall. This general lack of rainfall is a curious thing but is understandable when one recalls that rain is derived from the condensation of water from the oceans and other large bodies of water carried landward by the winds and then released over continental areas through precipitation. Although oceans lie to the north and the south, to the east and

to the west, the country receives extraordinarily small benefits from them as far as rainfall is concerned. The Arctic Ocean is frozen most of the year and the Indian Ocean is too far away, lying beyond great mountain barriers. The Pacific Ocean lies to the leeward of the continent. As a result, water drawn into the atmosphere from the Atlantic Ocean and carried eastward by the winds is the source of most of the rainfall throughout Russia, so that even in central Siberia more than three-quarters of the rain appears to be of Atlantic origin.

The principal rivers of Russia either flow to the ice-bound Arctic or enter the two seas, the Black and the Caspian, lying to the south. The Dnieper, the Don and the Volga empty into these isolated seas, while the Lena, the Ob and the Yenisei, and other smaller rivers, flow into the ice-locked Arctic. The Amur turns sharply north before it reaches the Pacific at the Gulf of Sakhalin at a point of latitude equivalent to that of South Labrador. It is amazing to realize that in Eurasia there are as many as 5,000,000 square miles that receive so little rainfall that there is no drainage to any ocean. These facts, as will be seen, have a distinct bearing on the conservation of land resources in Russia and are even leading the present government to an extraordinary experiment in water control that will be commented upon in a moment.

Wide belts of forest extend east and west across practically all of central Russia, the forest land comprising more than 40 per cent of the total land area of the country, and about one-fifth of the forest land of the entire earth. North of these forests lie barren wastes of tundra, a treeless land of lichens, moss and low brush, reaching to the shores of the Arctic Ocean. A

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large proportion of the forest lands of Russia lies in Asiatic Russia. Due to the absence of roads, these forests have not been exploited for lumber until recently but they are now being drawn upon and output is increasing steadily. Other forest reserves lie along the slopes of the Caucasus between the Black and the Caspian Seas. Time alone will tell whether the forests of Russia are from now on to be used wisely on a productive crop basis or whether their exploitation will follow the pattern of that of the Czarist days when, in many areas, widespread damage was caused by slash cutting, with the eventual disastrous results that are observable in so many other parts of the world.

Despite its great size much of Russia is virtually uninhabitable, being too cold or too dry or too inaccessible. What can be considered good agricultural land covers no more than 1,000,000 square miles, largely within a triangle that has its eastern apex near Lake Baikal and its western base extending from Leningrad in the north to the Black Sea in the south. The Ukraine is a part of this good land. Elsewhere, in far distant areas, there lie mineral deposits or occasional local areas of fertility such as the valleys of the Caucasus, but the climatic disadvantages that have been mentioned restrict normal settlement in vast portions of the country. So it is that within the fertile triangle as described are most of the cities, farms, railroads, industries and related activities that give strength to the Soviet Union.

One other aspect deserves mention, namely, the great expanse of level land in the fertile areas of western Russia. Most of the country from the borders of Europe eastward toward Siberia is a vast level plain some 3,000 miles in extent, rising little above sea level,

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except where the plain is intercepted by the Ural Mountains in its centre. This fact diminishes the threat of erosion by water in a considerable portion of the more productive areas of Russia. However, owing to the light rainfall in much of this entire region and its susceptibility to prolonged droughts, the land open to cultivation is highly vulnerable to erosion by wind. This threat has been and will continue to be one of the great problems of maintenance of soil fertility in Russia in the years that lie ahead. We in America have seen what can happen to the land in the Western plains states because of wind erosion, showing its worst climaxes in the Dust Bowl area. The Soviet Government appears to be conscious of this danger. It is a formidable one.

The fertile area lying within the great triangle, sometimes spoken of as the 'core land', was formerly open grassland country known as the steppes. Practically all of it is now converted to agriculture and is renowned because of the nature of the soil, known as chernozem or 'black soil'. It lies south of the great central forest belts where the natural growth of trees is limited by lack of sufficient rainfall. These rich agricultural lands, covering about 12 per cent of the entire country, represent the largest continuous expanse of black earth in the world. In the United States there is a more limited area of black soil running north and south, from North Dakota to Texas. Although the black-earth lands of Russia are spoken of as having been cultivated, it would be more correct to say that much of them was plundered, for year after year the harvests were reaped without sufficient thought being given to the nurturing of the soil by means of crop rotation or fertilization. Nor was adequate attention

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given to the protection of the fields from the hot, dry winds of summer when the parched earth was frequently swept away by windstorms. Consequently, this land has unquestionably lost some of its former vitality and richness.

Russia has suffered successive misfortunes from the general and widespread droughts. In the Czarist days these droughts frequently resulted in the destruction of virtually the entire season's grain crops in many regions, causing famine and millions of deaths. In the Volga region, for example, four droughts occurred from 1891 to 1921 that were so extreme that the entire harvest was lost. Cultivating the land in small strips under earlier peasant ownership left the agricultural areas more defenceless against drought than the present-day collective farms, which at least have the advantage that results from more intelligent methods such as the more extensive planting of winter crops, earlier spring planting and the cultivation of types of crops that are most capable of resisting drought conditions. Further, the availability of modern farm equipment permits more rapid harvesting when this is advantageous. Nevertheless, droughts will continue to be a major threat in Russia not only to the production of reliable harvests but to the protection of the health of the soil.

In order to try to cope with this situation in a more permanent manner, the Soviet Government, several years before the war, commenced work on an astonishing scheme. Part of the bold plan is the attempt to harness and control the Volga River so that the spring flow, which is equivalent to 70 per cent of the annual flow, can be retained and used for irrigation throughout the season. It is a noteworthy fact that the forests

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in the upper watersheds of the Volga were so ruthlessly cut in the decades prior to the revolution that water from melting snow during the spring thaws was not absorbed into the earth but rushed violently seaward, resulting in highly damaging floods during the spring and lack of water supply during the rest of the year. Just another repetition of the same old story! The Soviet Government has consequently undertaken what is perhaps the most extraordinary effort of its kind ever made by man. In scope and complexity it considerably exceeds the Tennessee Valley development in the United States. It was realized that if the Volga waters were to be diverted to irrigation, the level of the landlocked Caspian Sea, into which the Volga flows, would fall substantially because outgo by evaporation would be greater than the water received from the river. This would result in leaving ports, towns and industries upon the shore line high and dry, and would severely injure the important fishing industry. A search was then started to find additional water that might be siphoned into the Volga in order to increase its flow sufficiently to keep the Caspian at its normal level. It was determined to divert the waters of some of the northern rivers that flow into the Arctic Ocean, by a series of dams and reservoirs, into the Volga basin, and even to tap the Don River at a point nearest the Volga, close to the town of Kalach, the level of the Don at that point being higher than the Volga. This plan also had its complications and could only be adopted if it were found that the Don could spare enough water and still retain an adequate supply for its own various functions, including navigation, water supply for the cities lying along its course, and even the protection of the shellfish beds in the Sea of Azov

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at the Don's mouth that would not survive any material change in water conditions. Consideration for even the aquatic resources, a not unimportant source of food supply, is typical of the care that the Russians have taken to observe all of the interrelated factors that are involved. All in all it is a project of titanic proportions.

Questions occur to one: Would this whole costly enterprise be necessary if so much of the forest-covered slopes of the Volga watershed had not been ravaged in earlier years? Will the reservoirs eventually be rendered useless by becoming choked and filled with silt as has occurred so frequently in the United States? The Russians have been thorough in this plan, that is apparent enough. Have they thought of everything? Nature works as an integer. Is a component part being overlooked? If so, as time goes on, the plan may become another monument to man's lack of understanding. One recalls the great irrigation systems in the pre-Christian era in Mesopotamia, now a desolate and abandoned land. Have we yet learned enough to mould our civilization to the permanent and omnipotent forces of nature?

The transformation that is taking place in regard to a people and their land under the Soviet regime is well worth observing, whatever one's political or social point of view may be. Agriculture in prerevolutionary Russia was characterized by the concentration of a considerable portion of the land in the hands of wealthy individuals and by the prevalence of extremely small farms among the peasants. Many original peasant holdings, having become divided in successive generations among members of a family at the death of previous owners, finally became strips of land so small

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as to be totally uneconomical, with the result that great numbers of peasants were driven off the land, having been compelled to sell their small fields to a wealthy neighbour so that there was a serf-like dependence of the mass of the peasantry upon the large landowners. Notwithstanding this, there still remained up to the year 1927 more than 24,000,000 small farms in the Soviet Union having an average area under cultivation of 11 acres, representing, in turn, an area of more than 270,000,000 acres being worked by small farmers. The following year the government programme of collectivization of the land was put into operation and within four years thereafter 226,000 collective farms had been established that were cultivating more than 219,000,000 acres. This conversion of ownership has been carried forward steadily since that time and the collectivist system has been applied to activities on the land other than the cultivation of crops, such as the raising of cattle, pigs and poultry, the herding of sheep and the handling of forests. It is also being employed in an energetic attempt to develop living possibilities in the far northerly parts of the country.

On a collective farm all the land and livestock, together with farm buildings, are pooled into one enterprise instead of each peasant family looking after its own small farm. Each family, however, retains certain property rights including its own house or living quarters, with a small kitchen garden, some poultry and livestock, such as a cow or two, for the personal needs of the family. In organizing the work of the collective farm the peasants meet together, elect a chairman, a bookkeeper and other officials, and make the rules for their collective farm following the procedures laid down by the departmental managers representing the

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government. Each individual is paid according to the amount of work which he performs and one 'labour day' is measured by the ploughing of a certain amount of land, the milking of so many cows, the doing of so much office work, or carrying out other activities. After the reserves of stock or seed are set aside for the next season's production, the balance of the harvest is disposed of in various ways. Part of it is delivered to the government as income tax; another part is delivered in payment of farm accessories purchased from a governmental agency, or in payment of fees for the rental of government-owned farm machinery; a third portion, based on a percentage specifically prescribed by governmental regulation, is sold to the government for actual cash but at prices fixed in advance and lower than those obtaining in the open markets. In effect this is a direct form of taxation by the government upon agriculture. In return for such payments the farm receives advice and assistance from agricultural experts. These compulsory sales of grain, milk and other products are computed in proportion to the nature and acreage of the collective farm and consequently the quotas and types of products vary from district to district. A purpose observable in the entire system is that of stimulating diversified farming as well as maximum production. In retrospect, this enforced system of taxation by the government was used in earlier years as one of the methods—others were used—of coercing the individual owner to throwing in his work and property to the collective farm system. It is apparent that these same means can be employed for any purpose.

The remainder of the year's harvest or livestock production may be sold by the individual members in

the open market. The cash received from the sales to the government is similarly divided among the members of the collective farm in accordance with their earnings in labour days. There is no purpose here in going into other details of the Soviet system, except to mention that the foremen and managers of collective farms receive earnings several times those of the average workers.

During the early years of the movement to establish collective farms, first started by the Soviet Government in 1917, small headway was made and the programme was not producing the results that could be expected from power farming on a large scale. The great mass of the peasantry were utterly ignorant of machinery and were incapable of operating the tractors and other modern farm equipment that were being provided by the government. Reports in 1928 indicated that tractors on the collective farms were standing idle nearly half the time. In general, agricultural production was barely taking care of the people on the land and falling far short of providing enough for the cities that were growing so rapidly under the wave of industrialism sweeping the country. A turning point came through the creation of the first state farm near Odessa in the Ukraine. This new type of farming enterprise offered to service surrounding villages with its tractors provided peasant owners would merge their small holdings so that tractors might work large tracts according to the lay of the land. It so happened that this first experiment was completely successful. The families who merged their land that season for power farming with modern machinery received an excellent crop while their neighbours got very limited returns. This initial trial was closely observed by Stalin himself,

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who, in his next address on agricultural matters, pointed to it as the answer to the problem of power farming. At the same time arrangements were made whereby some 2,000 farm leaders from all over the country received free excursions to Odessa to see for themselves what this experiment was accomplishing. The season had been unfavourable in that locality and the crops of individual owners had been poor, but the villages served by modern farm machinery under the direction of trained agronomists, had got an extremely high yield. After paying nearly one-third of their harvest to the state farm for its services, the peasant farmers who had joined in the plan still retained three times as much per acre as their near-by neighbours. Thereafter the growth of state farms was very rapid so that in 1939 their number approximated 4,000, with an average size of almost 10,000 acres each. Many of these farms, in the years that followed, were organized on land which had previously been uncultivated, such as that in the dry steppe lands. They were not all directed to the growing of crops by any means, many of them being organized for the sole purpose of raising poultry, sheep, pigs and other livestock, including even 31 that have been established in the far north and are operating as reindeer farms.

While these radical innovations in methods of working and using the land were being made, another great change has taken place. This is the metamorphosis of a nation to industrialism. In the beginning of this century there were only 14 cities with a population in excess of 100,000 people and four-fifths of the population was dependent on agriculture. Industrial production amounted to about 40 per cent and agricultural production to about 60 per cent of the nation's total

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output. Just before the war industrial production had risen to more than 75 per cent. This great change resulted, of course, in an extraordinary growth of the cities. In the decade and a half prior to the war the populations of Moscow and of Leningrad each doubled, and by 1940 there were 81 cities with more than 100,000 inhabitants each. This compares with 92 such cities in the United States.

No hard-and-fast opinion can be ventured as to the ultimate effect of the spread of urbanization and industrialism upon the long-term protection of the natural living resources of the earth. Perhaps eventually a sound balance can be reached. We are far from balance now in that organic materials, both of plant and of animal origin, are consumed or disposed of in urban or industrial centres and not returned for the enrichment of the land from which they have been derived. The enormous and almost blind demands of the markets in great cities, sucking vast quantities and varieties of products from faraway land areas, may well be largely responsible for a process of land exhaustion that cannot continue indefinitely. One cannot help wondering whether in Russia the industrial net is not spreading so quickly as to stifle the earth.

It has frequently been a temptation in these pages to refer to the effect of the war on the groaning earth, even though the effect is difficult to define. Obviously the areas where war is actually being fought are violently injured. Yet the injury is not local but leaves its mark even in continents far removed from the conflict because of the compelling demand that war creates for forest and agricultural products. These are in truth poured into the furnace of war. In Russia the invasion of the Germans did great damage to the land,

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quite irrespective of the removal or destruction of vast amounts of agricultural equipment used for cultivation. Most of the territory invaded by the Germans suffered from lack of composting or proper crop rotation for an extended time, and the removal of the larger part of the herds of cattle and other livestock, useful for manuring the land, created a setback in land fertility that cannot be computed. These depredations appear to be of temporary effect but to some degree are liable to prove permanent when it is recalled further that every dam of importance in the occupied area was wrecked with all the destructive consequences of floods, and that there were widespread burning and cutting down of forests.

Because of the limitations of the truly productive and fertile areas of Russia, the present government has embarked upon a number of new experiments to increase the subsistence base of the country, especially needed because of the rapidly growing population. As in other countries, there was ill-planned and damaging cutting of forest areas in previous centuries either for timber or in order to convert the land to agriculture.

With so great an amount of land, even though much of it is covered by forests, it would seem at first glance as if the Russian people could open up extensive new areas for cultivation by cutting forests and adapting these areas to agriculture. Actually it is extremely difficult to do this because of the nature of the soil in most forest lands, especially where coniferous forests predominate. The growth of the science of soil chemistry is gradually producing knowledge as to those areas of the earth that can be successfully used for agriculture as well as those that cannot. In the good old days of the pioneer development in the United States early

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settlers radiated out into the upper reaches of New England and cleared land, much of which was covered by forests of coniferous trees such as pine, spruce and evergreen hemlock. Today there are endless chains of abandoned farms in this part of the country, owing in part to the fact that this region is, in the main, mountainous or hilly and thus subject to rapid erosion, but also, largely, to the fact that the nature of the soil does not lend itself to agricultural purposes. In Russia what is known as podsol soils cover nearly half of the entire country, such soil representing an organic layer derived principally from coniferous trees. Podsolization leads to a depletion of the basic favourable elements of the soil as well as to a general condition of soil acidity. This process is frequent in forested regions that are characterized by a relatively cool, humid climate, although it also operates in tropical climates and, as a matter of fact, in some regions is active in soils supporting hardwood trees as well as those supporting conifers. The point of this brief excursion into the nature of soils is merely to emphasize the fact that despite the vast expanse of Russia, the problem of obtaining as well as maintaining adequate subsistence for its large and growing population is anything but an easy one.

The efforts of the Soviet Government to gain greater productivity from the land are even extending to the tundra, that great cold and treeless land extending all the way across the entire northernmost part of the country along the Arctic Ocean. Northern Siberia is one of the few last great pioneering lands outside of certain regions in the tropics, and into it the Russians have gone and are going in large numbers. The government has organized programmes of systematic exploration, some for military-strategic reasons but others

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focused upon finding out to what extent land in the far north can be used to support human life. These activities also represent an effort to determine to what degree animal resources such as seal, walrus and whale in northern waters, eider duck and other arctic birds, or the white arctic fox and other fur-bearing land animals, can be utilized for food or profit. In this remote and forbidding country the ground is permanently frozen to great depths, even sometimes to 2,000 feet below the surface. However, plant life in the Arctic thrives in the active layer of soil that thaws out during the summer and the tundra blooms with a riot of verdure during the brief spell of frostless days, varying from 70 to 125 a year. Plant specialists are at work even in the Taimyr Peninsula, the most northerly land mass of Russia extending to within about 840 miles of the North Pole. Carried forward by exploratory enthusiasm, they have found that arctic raspberries and flax will ripen in the flood plains of the rivers. These plants, they claim, require as much solar heat to ripen as do barley and potatoes. During the long polar day plants grow with tropical speed and growth must actually be controlled by spreading tarpaulins over the hotbed frames in order to create artificial night. These activities are touched upon because they are symptomatic of human need and endeavour in these times when people are forced to find new places to live because of population pressures, or are drawn to remote portions of the earth in order to exploit its mineral wealth or other resources.

Two powerful nations, one in the West, the other in the East, are today locked in manœuvres of a fateful nature. Conjectures as to the eventual consequences to them, as well as to all other nations, are not pertinent

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here, but it is of high significance that both these nations are aware, to a greater or lesser degree, that all is not well with their living resources. Each country has, within the last few decades, commenced to take corrective steps. Each is proceeding along the lines of its own political or social ideology. In view of the fact that in Russia practically all the land belongs to the state, the directives concerning the use of forests, agricultural lands, water sources and animal life are formulated and imposed by the government. This procedure is, of course, virtually the opposite of that prevailing in America where all but a small proportion of the natural resources are privately owned and the government can do no more, in effect, than encourage and suggest wise and proper use of the land. It is important to realize that there exists in northern Europe today still another system than the so different ones of the United States and Russia, by which, in such countries as Denmark and Sweden, forests and productive lands, while resting in individual ownership, are strictly subject to the uses and regulations established by the governments. These countries exemplify a successful amalgamation of the interests of the individual and the state insofar as natural resources are concerned.

It is a startling coincidence that at this time the United States and Russia have, in relation to their respective populations, almost identically the same amount of land that is suitable for agriculture. In the United States the latest estimates indicate that there are some 460,000,000 acres, which, divided by the present population, represents 3.5 acres as a subsistence base for each individual. The 1,000,000 square miles of naturally productive land in the core land or great triangle in Russia, equal to 640,000,000 acres,

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when divided by the present population of that country, indicates an almost identical amount for each Russian. Both countries are facing the future on approximately equal terms as far as the basic assets for existence are concerned. The future holds the answer as to which nation will be the more successful in using and conserving them!

In view of the alarming developments that are now occurring in the United States its people will soon be faced with a momentous decision. Either they will permit the continuance of conditions whereby the diminishing, living, natural resources of this great continent may be exhausted to the point of national disaster or, through the adoption of a new concept regarding the responsibilities of ownership, these resources will be used and managed so as to protect the interests of the public as a whole. The arousing of opinion as to what is going on, both in the public mind and throughout colleges and schools, all leading to active and voluntary co-operation between people and government, is the American way; but will this awakening come in time? A democracy can rise in its might and organize itself all-powerfully to fight a successful war. This happens only when the people as a whole see the issue at stake. The issue facing America in regard to the preservation of its living resources is as critical, if not as immediate, as the threat of any war. Democracy has heretofore met with no equivalent test. If America permits the continuing exhaustion of the elements that are the source of her life and strength, any other social or political creed might serve her as well. It will not matter so much then, because the theory of a democracy presupposes a condition of reasonable well-being for all. Ideals and aspirations are rarely nurtured by want.

IX

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The countries of Western Europe have, as a whole, been far better cared for than other lands and so have suffered considerably less than other parts of the Old World. They have had to help them a truly beneficent climate without the extremes of temperature that are found in Russia, and with plenty of rainfall, much of it of a gentle nature, and an even ordering of the seasons. There is scarcely any other part of the world so fortunate in this respect. Western Europe has a long growing season. The countryside is, in the main, not too hilly and is, as well, naturally fertile. It has been cared for by people for hundreds of years—people who lived and worked on their land and did not think of it so much as a field for exploitation as a sacred trust and means of subsistence. Land in many regions of Europe was not as a rule held in great tracts by any one person, but was divided up and held in relatively small tracts for the use and benefit of individual owners and their families. Thus it was protected and cared for.

European peoples early became intelligent tillers of the soil, and were not nomadic but lived for generations in one place. They loved their land and learned to return to it much of the substance they drew from it. It early became axiomatic to use manure to the fullest possible extent, and today in France and northern Italy you may see farmers sprinkling their hayfields

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with liquid manure before a rainstorm, and collecting from the public roads every scrap of animal refuse to add to the compost heaps that are a feature of nearly every household. With this sort of intelligent care the soil of a region may be kept in a condition of health and productivity indefinitely, as has been done in many parts of Europe.

Not all of Europe, however, has been so fortunate. In some places, particularly on coastal plains lying below mountain ranges, cultivation of the soil has been practised on unterraced slopes that have gradually become eroded during the seasons of heavy rainfall. An outstanding illustration of this, within historic times, is provided in Italy by the Pontine Marshes. Originally this was a region of fertile farms. These marshes resulted from putting the surrounding mountain slopes to cultivation in an effort to feed the growing population in the days when Rome was a great power. Gradually those who lived on the coastal plains had to move away from their formerly productive lands, for their streams became choked with silt that washed down from the country above them, and in time a large part of the coastal area became a malarial swamp which threatened the health of all those who lived near by. One of the causes of the fall of Roman civilization may well have been the declining health of Rome's people, resulting in turn, and to some degree, from the misuse of her land. The Pontine Marshes covered a large area where as many as sixteen towns had prospered before the rise of Rome to power.

For centuries after their formation the marshes remained a virulent breeding ground of pestilence. From the fourth century A.D. until the twentieth century the marshland defied every attempt made by man to

reclaim it. Emperors and Popes in long succession tried what skills they had against the dangerous wasteland, but with no results of any lasting significance. Finally in 1931, owing to modern engineering skill, scientific knowledge, the expenditure of huge funds and a number of years of heavy labour, the marshes were at last cleared and reconverted into fertile and healthy land. They illustrate only too well the vast effort required to restore what man has ruined.

The incident of the Pontine Marshes illustrates another thing, the insidious danger to any part of the world where too many try to live on a land of limited production—for all land, however fertile and well cared for, is bound to be limited in its production. In a country like Italy, where the population pressure is about 830 people per square mile of cultivated land, the country is almost certain to suffer. People not only take more from the soil than they can put back, but they set about clearing more land on slopes above the plains, and thus release the force of heavy rains which in a few seasons, or even a single season, not only can destroy the new-cleared areas but can bury or ruin with debris all the fertile tracts below on the plains. Where plains lie at the foot of steep mountains, and where populations are too great, this is almost certain to happen. It has happened in many parts of Europe, in France as well as in Italy, and too often men have tried to curb the inevitable result by setting up a sort of warfare against nature. They build runoff channels and dams and spillways to carry away the excess water of the rainy months, and to protect the lower lands from erosion or from being covered with erosive material. They do what they can, often very effectively, to prevent the loss of life which so often accompanies

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floods and torrential runoffs. But this system of pitched battle with nature is in effect a treatment of symptoms rather than causes. It is like attempting to cure a person who is very ill, instead of attempting to prevent the illness in the first place. Treatment of symptoms is suggestive of a form of conflict. The handling of first causes, on the other hand, may be considered as a sort of friendly relationship, the forestalling of difficulties before they occur, the getting along with nature, instead of fighting with her after she is in revolt. Man must somehow, before it is too late, realize that he is a part of nature, and that nature is not his enemy, for it is only by adjustment to the processes of nature that man, like all other living creatures, can establish a friendly balance that will make life on this planet possible for generations not yet born.

It is not invariably true, however, that population pressures result in damage to the fertility of the land. Even within Italy today there are regions, notably portions of the Lombardy plains, where the health of the land has been guarded for centuries. In Japan, no larger than the state of Montana but with a population one-half that of the United States, the people with meticulous care, skill and intelligence have maintained the relatively limited amount of arable land that country possesses, only one-fifth of its total land area, in a condition of productivity. But these instances, together with but a few others, are the exception to the general rule. They are encouraging as proof of what can be done.

Mahomet is supposed to have believed that the plough brought servitude and shame to mankind, and perhaps this Eastern idea, and the nomadic life it implied, had something to do with the almost unbeliev-

able waste of fertile land in Spain. The great Spanish painters of earlier days depicted stark and fantastically beautiful Spanish cities built on rocky crags above wasted and gullied slopes. No one sensitive to the welfare of the land can look at these pictures without a feeling of foreboding. The plight of Spain today is exactly what one might suppose it would be, considering the plight of the land itself. The desperate and degraded condition of the countryside came about more through greed than through need, and its history dates back to the days when Spain was powerful and prosperous.

Before the fifteenth century there had grown up in Spain a vigorous and influential organization of migratory shepherders, known as the Mesta. They moved their flocks northward in summer and southward in winter, over a land sparsely populated and at certain times threatened by Moorish invasions that tended to prevent settled populations from establishing themselves, especially in the lands towards the south. They had the land almost entirely to themselves, and followed stated routes for their migrations—long road-like strips of grazing land where they were allowed to move freely as the seasons warranted. In their migrations they passed many communities which by law were permitted to fence in the ‘commons’ or communal lands belonging to the villages, and these fenced places were, for many years, left undisturbed by the migrants. But the migrants had the privilege of cutting small trees and branches to supply their needs in fuel and fodder as they went along, and this seems to have been the beginning of misuse of the untenanted lands through which they passed. Originally they were not considered hostile by the settled population, for their

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sheep in passing helped fertilize the fields, and after the grape harvest they not only enriched the vineyards but nibbled back the vines and thus saved many a vineyard owner the trouble of pruning.

When Ferdinand and Isabella came to the throne, however, they saw in the wool industry a great source of wealth for the crown and for their country, and they encouraged it beyond all other industries. Wool had high value in the foreign markets, and was compact and easy to ship, so in every way they could they encouraged the Mesta. Thus there sprang into being a number of laws and local regulations which favoured the migrants against the settled population. The common lands in some cases were thrown open to the sheepmen, taxes for their use or their non-use were levied, and the money collected reverted to the crown or to political agents of the rulers. A squatter law was enacted allowing migrant shepherds to become permanent owners of land belonging to others who had not happened to discover the presence of the squatters. Everywhere land was overgrazed, forests were burned off to provide extra pasturage, young trees were cut down for fodder or firewood, and the desperate cycle of greed and overuse and erosion was set into motion. The Mesta for a time exercised so great a power as a political organization that little or nothing could be done against it, and it continued long enough to ruin a large part of Spain. The same sort of migratory sheep-raising had already produced havoc in South Italy and Tunisia, but the Spanish situation was more flagrant and more complete in its devastation of the land, which has not recovered since, and shows, after centuries, the plight of land misused by man. The final overthrow of the Mesta came about through political moves origin-

ated by the nonmigratory population, who were determined that they too should prosper by the wool trade, without the work and uncertainty of moving about from place to place. They stayed at home and raised sheep and levied taxes on the migrants, and carried on political and economic feuds which continued for many years. And so in the end the Mesta was overthrown, but not until it had in all too real a sense overthrown the balance of man and nature in Spain.

And there was a contributing factor: Spain became aggressive, and laid plans to become a great maritime power. To build her ships she cut her great trees, and the forests and all their related resources were sacrificed to the ambitions that promoted her trade. All this happened because of a combination of wish-for-power, greed, and lack of realization of the inevitable results that would follow the misuse of the land. In the light and knowledge of the present the whole senseless cycle of waste in Spain may look like something that adult human beings would never tolerate if they were aware of it. The terrible and pitiful fact is that the people of other countries are engaged in just this sort of wastage of their prime resources today. They—and this includes the people of the United States—are too near to the picture to realize what is happening.

The nomad invasions of Europe were a main cause of much destruction of land. The historian Gibbon was aware of this when he wrote of the Mongols: 'From the Caspian to the Indus they ruined a tract of many hundred miles which was adorned by the habitations and labours of mankind, and five centuries have not been sufficient to repair the ravages of four years.' In 1223 the Turks fled from the Mongols, going as far west as Armenia. Devastation of the land followed all

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this sort of warfare, for the invading hordes killed the settled population and thereafter the land had no protection by those who would have used it well. Forests were cut and burned, flood waters damaged the countryside, and on the plains of Hungary drifting sands began their new work of cutting away or covering over the rich soils that are one of Europe's heritages. Sheet and gully erosion followed, and have occurred in much of central Europe. Fortunately for this part of the world, those who continued on the land were intelligent in their use of it, and succeeded in restoring much of it to a state of fertility.

Just as political influences, such as the Mesta in Spain, can result in great damage to the land, so can certain social customs. In the latter category one that deserves mention is the French system by which land, upon the death of the father, is usually divided up among the children rather than left to one child. This has resulted in land being cut up into smaller and smaller strips, until in some places a child's inheritance may be no more than a few yards in width or length. If the strips of land lie on a level, they may be in but small danger from erosion. But if, as often happens, they are on a slope, and the division of land results in strips running uphill, then there is great danger to the land, for heavy rains may cause rapid erosion. Strips of land must usually have access to a service road, and service roads are likely to lie along valley bottoms. Thus very often the land served by the roads is divided into uphill furrows, and unless the various owners agree to cut it up in a different manner and, by following the hill contours, to evolve a set of small terraces, no one can have much benefit from the land. The French Government some years ago set up a plan to

build service roads so placed that horizontal rather than vertical division of the land could be achieved, and it also extended aid in financing the purchase of adjoining strips of land by individuals or groups, so that the land could be farmed in blocks rather than in strips. Where strips have been established that follow the contours of the land, the customary system of dividing land among the children has been a help to the land rather than a hindrance, and has resulted in much painstaking terracing and sluicing for surplus water runoff, and impounding of water for later use.

England has shared with western Europe a uniquely favourable record in maintaining her land in a fertile and productive condition despite centuries of use—in the main for the same reasons. Here, in addition, a social custom has played a helpful part, namely the passing of the ownership of land from one generation to the next by primogeniture, which has tended to prevent the division of land into small lots or strips as in France. Stone walls as well as thick hedges surrounding most fields have also contributed to the continuance of soil fertility, for there can be little erosion in closely walled fields. However, sheet erosion is not uncommon in England, while land deterioration from more active forms of erosion is quite general in the hilly country of Wales. In the face of such an apparently favourable situation it is the more startling to read the record of the debates that took place in the House of Lords during 1943 and 1944—held even during one of the most critical periods of the recent war. These debates reflected a growing apprehension that conditions were far from satisfactory as regards England's soil fertility in its relationship to the health of the English people. The speeches were punctuated by vigorous dis-

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pute as to whether 'organic' or 'chemical' methods provided the better solution to land restoration. A number of speakers voiced the opinion that there was something very wrong in the 'life cycle' and that prompt action was needed 'in order more definitely to establish the interrelation between morbid or deficiency conditions of soil, plants, animals and human beings'. Reference was made to the increased decline of the water table and the extraordinarily low level of springs and wells. Attention was called to the fact that New Zealand and Australia had heretofore provided a very large proportion of the food on which England had subsisted in the past but that recent governmental reports from both those countries indicated that deteriorating land conditions had reached the point of being a grave problem, and that therefore England could not expect to receive imports of land products from either Australia or New Zealand equivalent to those it had received in the past. There was general recognition of the fact that the questions raised in the debate were extremely complicated in their nature and it was estimated that were a Report by a Royal Commission to be prepared, between ten and twenty years would be needed for its completion. Speakers for the government took a defensive attitude. They were not prepared to recognize the need for a special Report by a Royal Commission and the motion for its preparation was withdrawn.

In the meanwhile the processes of nature will continue to move upon their ordered courses.

* * *

The speaker who was troubled by the situation in Australia and New Zealand had good reason.

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It has taken only about six generations to bring widespread conditions of land illness to Australia, as well as to New Zealand. This is fast work and almost equal in velocity and extent to the grievous injuries done to the land in the United States in a similar period of time. Australia and the United States are of almost identical size but all of the central part, amounting to about 40 per cent of the former country, is a great natural desert. The United States is far more fortunate in that only about 14 per cent of its area is desert and uninhabitable.

Some of the causes of land injury in Australia are identical with those found in other countries, such as the highly unfortunate destruction of forests which, to begin with, were very limited in extent, covering not more than 5 per cent of the total land area. Consequently Australia today is in the unnecessary and regrettable position of having to import more than 40 per cent of its annual timber needs and considerably less than 2 per cent of the country now has protective forest cover. Trees were regarded as an encumbrance by the early colonizers who were opening up the land for grazing and agriculture, and their devastating methods of burning the forests resulted in a vast amount of wasteful destruction.

In a recent conversation an Australian naturalist, who had travelled through many regions of his own country in pursuit of his professional interests, stated: 'Unless you have seen it with your own eyes you can form no idea of the frightful havoc wrought in watershed areas by bush fires, with consequent fierce acceleration of erosion in mountain country. Australian eucalyptus forests with associated dryness of summer periods burn more fiercely than any other forest in the

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world. Bush fires in our country burn even the roots of trees two feet below ground so that forest giants fall in all directions.' He added, however, that of late the situation was more encouraging because of 'the effective remedial measures now in operation'. May it not prove to be a case of closing the stable door after the horse has run away!

One of the most precious physical possessions of Australia are her rivers, dependent for their regular flow on the conservation of the forests in their watersheds. It is pathetic to look back and find that some of the early governors forbade the clearing of river-banks and then to observe that these prohibitions were soon forgotten, so that in the second half of the nineteenth century tree destruction by burning or ring barking destroyed the forests on a gigantic scale. This deforestation has contributed to the loss of rhythm of the Murray, the greatest of the rivers of Australia, which is beset by alternating seasonal floods and abnormally low water.

Incidental changes of an unfavourable nature have also followed deforestation. For example, it has of late been observed that the low-lying lands on the north coast of New South Wales, which originally were seldom subject to frosts, have, with the denudation of forests on the surrounding hills, experienced annual frosts, the probable explanation being that through the absence of trees the cold air of the highlands now flows unchecked and untempered down the sides of the hills to the valleys of the lowlands.

Then, too, Australia has suffered from the usual consequences of opening up lands to agriculture when proper land-use methods are not employed. For instance, the wheat lands of New South Wales are ex-

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tensively and seriously damaged by erosion, owing partly to the fact that here wheat is often grown on undulating land with slopes of from 3 to 8 per cent. Much of the land in New South Wales would now be recognized as too steep for cultivation and safer for use as pasture. In the hilly country of the coastal dairy districts, rapid erosion has followed the cultivation of corn and other fodder crops, and the situation with regard to water erosion in the cotton belt in Queensland is also a delicate one.

Serious wind erosion has occurred in the semi-arid belt in the states of South Australia and Western Australia bordering the great central desert, partly because of the use of the land for growing wheat in regions in which there is extremely little rainfall. Here too there is the ever-present drifting of sand from the great desert.

There have been two other causes of serious land illness in Australia as well as New Zealand. The first of these is the sheep industry, which, as is well known, has been developed to an inordinate degree. The other cause has every element of fantasy. This is the rabbit scourge, which is a stark example of the consequences that follow ignorance of the relationship of animal life with land health. The chain of events following upon the blind misstep of a handful of early colonizers, nostalgic for the pot-shooting amenities of their home country, verges on the incredible.

As to the sheep, there could be no situation that better exemplifies the dire consequences of overusing the land for purposes of trade or profit than that of the growth of the sheep industry in Australia, which has been an effort to gain from the land more than it is capable of producing. The origins of this industry from

which, from a temporary point of view, the Australian people have gained such quick returns, but because of which the long-term or permanent health of the land has suffered so greatly, are worth a momentary review. In the early part of the nineteenth century England had become the world's most important centre for the production of woollen goods and the spindles and looms of Yorkshire were demanding greater and greater quantities of wool. At that time English manufacturers were buying most of their wool in Europe either from the Spaniards or from the Germans. We have already seen the effect of the growth of the sheep industry in Spain under the Mesta and its effect upon that country. Spanish wool, however, was not retaining its quality and English buyers were switching to the wool of excellent quality that came from the Saxon Merino sheep. Woolgrowers of northern Europe, however, had to struggle with the rigours of a severe winter climate and this situation pointed the way to Australia's great opportunity whereby the then most wretched of British colonies could pay its way and even win its position as a commonwealth by contributing to the stupendous energy of England's economic expansion. By 1882, following a couple of decades of experimental breeding, the wool of Australian sheep was judged equal to the finest Saxon. The boast was made by Australian colonizers that their country 'contained tracts of land adapted for pasture so boundless that no assignable limits may be set to the number of fine wool sheep which can be raised', and from that time on English manufacturers depended increasingly upon Australian wool and English capital assumed great influence in the development of this industry. In effect wool provided the economic impulse that opened up

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the Australian continent and, incidentally, provided one of the reasons for the early overcutting of forests in the ill-considered attempt to get more pasture land at so great a cost to Australia's present-day land economy. Anyone who has not seen herds of sheep, each numbering several thousand animals, can form no conception of the damage to the land of which they are capable. Both sheep and goats are close-cropping animals and unchoosing in their readiness to eat all kinds of living plants, even to their roots. Further, plant cover that is not consumed is trampled and injured by the thousands of hoofs. When their numbers are not properly balanced or controlled, these animals are one of the major causes of injury to the surface of the land, of erosion and of eventual desolation. So it has been since before the days of Christ. So it has proved in many parts of Australia and of New Zealand.

It was a sorry day for Australia when an early colonizer from England packed a few innocent-looking rabbits aboard ship and sailed for his new home in the land 'down under'. This individual, whoever he was, together with occasional others who did likewise, has unwittingly cost the Australian people monetary losses that run into hundreds of millions of dollars and has caused injury to the land resources of Australia, much of it even of a permanent nature, that is beyond computation. Each and all of these men were blind to the fact that the predatory animals that existed in Australia, such as dingoes and several species of hawks, would be incapable of acting as automatic natural controls in keeping a rabbit population in balance. In passing, it should be noted that the subsequent importation of wild foxes, as a control measure, proved a complete failure. Nothing short of a thorough

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advance knowledge of the intricacies of wild life ecology could have prevented the avalanche of trouble that continues even to this day.

The first record of the existence of rabbits in a wild condition in any Australian state appeared in 1827, but the menace really dates from 1859 when the clipper *Lightning* arrived in Hobson's Bay with twenty-four wild rabbits for Thomas Austin of Barwon Park near Geelong. These were liberated and within three years rabbits first began to be referred to as a pest. Six years later Austin had killed off some 20,000 rabbits on his own and adjoining properties but was confounded at being forced to estimate that there were at least 10,000 left. At about the time of their introduction into Victoria there is recorded the ironical touch that a man was charged at the Colac police department with having shot a rabbit, property of one John Robertson of Glen Alvie, and was fined ten pounds, in accordance, no doubt, with the old poaching laws of England, where game was the property of the landowner. A few years later Robertson's attempt to stamp out the rabbits cost him £5,000. Within the next thirty years the animals multiplied to such a degree and migrated so widely that they became a pest of the most critical kind practically throughout the entire Commonwealth. In the seven years from 1883 to 1890 the New South Wales Government was forced to spend not less than £1,543,000 in its attempt to control the scourge, and today rabbit control both in Australia and in New Zealand is a financial load upon every community. Many methods of eradicating this pest have been attempted. In Western Australia more than 2,000 miles of fencing was erected at a cost of almost £500,000, but after it was all up it was found that some rabbits were

already on the other side of the fence! Unfortunately, incidental to the compulsory use of poison for rabbits, there has been a very great destruction of wild-life as well as livestock, and phosphorus poisoning, employed for rabbit control, has been one of the principal causes of death among the marsupials and native birds.

The feeling of concern and apprehension regarding rabbits as a pest has even had psychopathic effects, as illustrated by the testimony of a witness before one of the parliamentary commissions who happened to live in one of the arid regions of South Australia where rabbits were a real curse. This witness stated that the rabbits in his part of the country had developed a long neck and miniature hump indicative of their capacity of living for long periods without water. These animals, when pressed to it, can live on bark and thus have been the cause of widespread killing of scrub growth by ring barking it, in addition to consuming millions of seedlings. Another observer has pointed out that rabbits eat the hearts out of pastures by their habit of selective feeding, taking the best grasses and leaving the worst, and have in effect been the cause of creating new deserts. A writer in the Australian encyclopædia estimated that 'with the removal of the rabbit the capacity of the Commonwealth in carrying livestock would be increased by 25 per cent'. This may be somewhat of an exaggeration, especially now that in the better pastoral lands the rabbit is fairly well under control. There are at least a few entries on the credit side of the rabbit ledger, such as the use of the animal for its fur as well as for its food value, as evidenced by the fact that in the decade ending in 1924, 157,000,000 frozen rabbits were exported and in the same period they exported

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more than 700,000,000 skins. But the harm done to both Australia and New Zealand by the unwitting actions of a few of the early colonizers is and will continue to be irreparable.

The outlook for the adoption of a really effective over-all conservation programme in Australia is still not promising. There is inevitable friction, the result of long-standing jealousy, between the Commonwealth government and the governments of the various states. The conflict of the Lands Department, which for decades pressed for the settlement of the forested areas, and the State Forestry Departments that resisted this process, has diminished but is not yet wholly resolved. Forestry was not one of the functions transferred by the states to the control of the Commonwealth, and the adoption of an intelligent long-term production and use programme of the remaining forest reserves depends too greatly upon the degree of voluntary co-operation it is possible to obtain among state authorities. There is still a wide divergence of opinion regarding the population that the country is capable of supporting. One school even believes that, somehow or other, the continent can ultimately support 100,000,000 people or fifteen times its present numbers. Another school of thought claims that twice the present population of 7,500,000 would represent the optimum density. One obstacle to straight thinking regarding population possibilities of Australia revolves around the fact that popular opinion persists in the belief that large area means proportionately large resources. But when the great extent of natural desert land is removed from consideration and the climate, topography and soil of the habitable areas have been analysed, it seems that four-fifths of the country could not be settled much

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more densely because of rainfall deficiency or other negative factors.

There has not been made as yet a comprehensive study of the land resources of the country. In this respect the United States, with the far-reaching work done by government departments in the last two decades, is in a far more favourable position. All in all, Australia is still going pretty blind as far as the ultimate protection of its living assets is concerned.

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There was a time, just the other day as time goes, when the Western Hemisphere could be called 'the New World'. It is 'new' no longer. Quite the opposite. In many parts of the two great northern and southern continents, once boundless in natural riches, there already are large areas, death spots, of wasted man-made deserts. Millions of people are approaching the final crisis of human life—that of obtaining a minimum subsistence from the earth.

It would be a relief if these observations on land conditions in various parts of the world could record a favourable situation in Central and South America. One clings to the feeling there must be some continent where the relationship between man and nature is not out of balance. However, it is becoming apparent that growing population pressures, combined with the general absence of realization of the ultimate effects of misusing the land, are bringing about conditions in the southern half of the New World that in many respects are unparalleled in their seriousness. Not until recently has there been any awakening in Latin America to the growing danger resulting from the wastage of natural living resources. The first comprehensive movement to get at the facts was initiated only five years ago by the Pan-American Union, an international organization created and maintained by the twenty-one American Republics and designed to foster constructive co-

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operation among them. A considerable amount of work has already been accomplished, and surveys of a few countries have now been completed. While reports concerning all the countries in Latin America are not yet available, there are good reasons for believing that the alarming deterioration of land resources evident in the countries covered by the recent investigations is indicative, if not typical, of what is going on throughout the entire continent. After two years of study in the field the chief specialist engaged by the Pan-American Union to conduct these surveys has been moved to characterize South America as the 'vanishing continent'.

Coming events often cast their shadows before them just as past events frequently prove to be harbingers of the present. We have seen elsewhere how centres of civilization have sprung up in days long ago in various parts of the earth only to vanish after their shining period of strength and glory had been spent. More and more, in the light of present knowledge, can we be sure that one of the causes was almost always man's destruction of his living environment. In this New World, the Western Hemisphere, there once existed a great centre of human culture, adorned by buildings of superb architecture, which could not withstand nature's final retaliation. Today the ruined cities of the old Mayan Empire, in the Petén district of Guatemala, which flourished for almost six hundred years commencing in the fourth century A.D., give mute evidence that they were centres of a large and flourishing population. Many theories have been advanced at one time or another as to why this remarkable civilization disappeared: earthquakes, violent climatic changes, recurrent epidemics of diseases such as malaria and yellow fever, foreign conquest and civil wars, intellectual

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and aesthetic exhaustion and, lastly, the failure of the Mayan agricultural system to provide for an ever-increasing population. The long trail of scientific inquiry, in itself fascinating, lends support to the theory that the old Mayan Empire came to its end principally because its people employed faulty systems of agriculture and denuded their land of its forests. To-day the forest jungle stands again in silent watch; the cities and their people are no more.

A thousand years have passed. In the light of what is happening today in Central and South America, the episode of the Maya takes on the form of precursor—a warning unheeded. Just to the north in Mexico, the story, with certain variations, is now being repeated. The findings of the recent survey of this country made by the Conservation Section of the Pan-American Union are disturbing to a degree and point to a situation of increasing gravity, regarding which no adequate corrective steps have yet been taken. The studies were carried out with particular thoroughness because it was recognized that the cultural and geographic conditions of Mexico were similar to those of many other Latin-American countries and consequently the findings could be useful to other countries in the Southern Hemisphere. Many of the conditions uncovered in the Mexican study are indicative of those that exist in most of the countries that lie below the Rio Grande.

Mexico is in the main a mountainous country and consequently is unusually susceptible to violent erosion. It is estimated that less than one-third of the land area is level or even approximately level, with the result that only a relatively small portion of the whole country can safely be used for agriculture in the

absence of extraordinary precautions that are not now being taken. Because of this scarcity of arable land, the people of Mexico have extended the cultivation of crops to increasingly steep slopes, resulting in severe and widespread erosion. Much of the country was once heavily forested but Mexico is now actually beginning to face a forest famine, with the usual after results of deforestation in the form of disastrous floods, the disappearance of springs and the failure of regular water supply. Within the last fifteen years Mexico's population has increased by about one-third and now stands at more than 22,000,000. The pressure of an increasing population, combined with the mounting injury to existing cultivable areas by erosion, is forcing people to use land that is totally unadapted to the growing of crops and at the same time is compelling the country to rely on imports for much of its basic food supply. It may be recalled that land hunger was one of the principal dynamics of the Mexican Revolution.

The industrialization of the country depends to such a considerable extent on its water resources that the reckless deforestation now taking place is cutting at the roots of Mexico's industrial programmes. One of the reasons for forest destruction is that this country, like others in Central and South America, is handicapped by a scarcity of coal. Consequently there is a lot of timber cutting to produce charcoal so widely used as fuel for cooking and heating.

Years ago more than forty National Parks were established. These areas are now being invaded by lumbermen and by cattlemen. At the time of the recent survey referred to above there was not a single forest guard living within miles of some of the National Parks so that they had no effective protection.

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There is general ignorance of the important part that animals of every kind play in the life complex of nature. Not only have the larger forms of wild life been reduced to almost the vanishing point, but non-game birds, as well as smaller mammals, are shot 'for the pot'. It has also been observed that common birds such as the junco, Steller's jay, robin and bluebird are becoming rare near populated areas. Those that survive are so wary, because of the hunting they have suffered, that it is frequently impossible to come near them, whereas similar birds in the United States, where they are carefully protected, are easy of approach. The monetary cost due to the destruction of insect-eating birds is just another item of 'loss' in the economy of this country.

A distinguished Italian botanist, with a profound knowledge of southern Mexico, has stated categorically that the state of Oaxaca will be a desert within fifty years. The Chief of the Conservation Section of the Pan-American Union, while claiming no gift of prophecy, believes that if present trends are allowed to continue most of Mexico will be so severely denuded within a century that the country, at best, will only be able to maintain its people at the barest subsistence level. If the present velocity of despoliation could be accurately measured, and if it were to persist, it is probable that this prediction would prove to be too temperate. In any case, the present situation portends the eventual collapse of the whole economic structure, and implies that, while few people recognize it, Mexico today is engaged in a desperate struggle for survival.

The pattern of land use still follows that of the ancient populations—'cut, burn, plant, destroy, move on'. It is a method known as *milpa*, common not only

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in Mexico but in most other countries in Latin America and, for that matter, elsewhere in the world. Such a system is possible where there are limited numbers of people who have plenty of room to move on from one place to another, leaving the wounds on the land behind them for time and nature to heal. Under the pressure of tremendously increased populations, and with the growth of cities and towns and the disappearance of new and unspoiled land, the eventual results of the system are fatal.

Recent similar surveys of Guatemala, Salvador, Venezuela and Chile show that the trend is in most respects similar to that in Mexico. In all these countries the combination of land misuse and population increase is resulting in a rapid deterioration of their natural living resources. A situation typical to many similar ones is that brought to light in the recent survey of Chile showing that the broad valley of the Bio-Bio River system, once an extensive fertile region, is now virtually useless for agriculture. This unhappy loss was brought about by the violent erosion that followed the stripping of the surrounding mountains of their forest cover. Most of the topsoil of this once fertile valley has been carried seaward and now lies in the Pacific Ocean, a vast sludge that, in turn, has smothered much of the marine life, such as the shell-fish beds along the coast. Imagine a condition such as that in Chile where not only is the clearing of the land by setting fire to forests still a general practice, but the government has not even taken the initial step of checking this ancient practice by establishing a corps of fire wardens or by adopting other forest-protective measures. In other words, while the government spends large sums annually for naval and military

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purposes in order to protect the country from attack from without, it is permitting an asset necessary to the survival of the nation to be assaulted and decimated from within.

In Argentina great areas of grassland have been converted to the growing of wheat and corn just as they have in the Middle West in the United States. Lack of precaution in holding the topsoil by cover crops and conserving its fertility by crop rotation and other means, combined with much overgrazing because of the huge cattle industry, has brought about a situation that is similar in many respects to that in the Dust Bowl region of the Western states in our country.

When one looks at South America as a whole in an attempt to define its principal physical and climatic characteristics, it becomes evident that by far the greater part of its land is quite unsuited for cultivation unless advanced agricultural practices such as terracing, contour ploughing and strip cropping are generally adopted. These practices are noteworthy today by their absence. The continent contains only limited regions that have an agricultural value comparable to the great expanses of naturally fertile lands in the United States and Canada, in western Europe or in Russia. Land with a slope of less than 8 per cent—in other words, land that lends itself readily and safely to cultivation—is extremely scarce except in the pampas of Argentina, in parts of Patagonia and in the Amazon basin. In turn, a study of the rainfall charts indicates the unfavourable situation of many of these level areas because climatic variations run to the extremes of either too much or too little precipitation. The deficient rainfall that characterizes the great Peruvian desert extends across the highlands of Bolivia

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into southern Argentina. In violent contrast, the vast Amazon basin lying to the north-east in Brazil, extending southward from the equator, receives torrential rainfalls. Most of the region is densely covered by tropical forests. When the tree canopy is removed the land suffers rapid leaching of the life-supporting mineral elements in the soil because of the violence of the tropical rains. Most of this area, at the same time, is handicapped by extremely high temperatures.

As a result of these prevailing physical and climatic characteristics great numbers of the people of Central and South America are either forced to concentrate upon and overexploit the relatively limited regions that are naturally fertile or are compelled to move on and cultivate steeply sloping and even mountainous country, with the inevitable after result of widespread deforestation and erosion. That which happened in Petén is threatened from the Rio Grande to Cape Horn. The story of the old Mayan Empire may prove to be a microcosm of one now unfolding on a continental scale.

* * *

And now to come to the United States, the country of the great illusion, the country that 'can feed the world'. What has happened there during its turbulent and inconceivable period of development and what is happening there today?

The story of this nation in the last century as regards the use of forests, grasslands, wild-life and water sources is the most violent and the most destructive of any written in the long history of civilization. The velocity of events is unparalleled and we today are still so near to it that it is almost impossible to realize what

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has happened, or, far more important, what is still happening. Actually it is the story of human energy unthinking and uncontrolled. No wonder there is this new concept of man as a large-scale geological force, mentioned on an earlier page.

In the attempt to gain at least some perspective let us review a little. The people came to a country of unique natural advantages, of varying yet favourable climates, where the earth's resources were apparently limitless. Incredible energy marked the effort of a young nation to hack new homes for freedom-loving people out of the vast wilderness of forests that extended interminably to the grassland areas of the Midwest. Inevitably the quickest methods were used in putting the land to cultivation, not the desirable methods. Great areas of forest were completely denuded by axe or fire, without thought of the relationship of forests to water sources, or to the soil itself. Constantly there was the rising pressure for cultivable land caused by the rapid inpouring of new settlers. By about 1830 most of the better land east of the Mississippi was occupied. In that year there were approximately 13,000,000 people in this country, or less than one-tenth of the present population. In the meanwhile the land in the South, long occupied and part of the original colonies, was being devoted more and more extensively to cotton, highly profitable as export to the looms in England, and tobacco, for which there was a growing world market. These are known as clean-tilled crops, meaning that the earth is left completely bare except for the plantings and is a type of land use most susceptible to loss of topsoil by erosion. Today a large proportion, in many areas from one-third to one-half, of the land originally put to productive use for the

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growing of cotton and tobacco has become wasteland and has had to be abandoned. It is not unusual for Southerners to blame the Civil War and its after-effects for their impoverishment. There are other reasons.

There is no particular point in tracing the westward surge of settlers over the great grass plains that lay beyond the Mississippi and on to the vast forested slopes bordering the Pacific. Everyone knows the story. It is significant, however, that the movement, dramatic as any incident in human history, was symbolized by the phrases 'subjugating the land' and 'conquering the continent'. It was a positive conquest in terms of human fortitude and energy. It was a destructive conquest, and still continues to be one, in terms of human understanding that nature is an ally and not an enemy.

Incidentally, it is not generally realized that the prairies, the long-grass country, and the plains, the short-grass country, occupy nearly 40 per cent of the land surface of the United States. Here today are the greatest corn and grain producing regions in the world—as well as the great natural ranges for cattle and other livestock. Here limitless areas of natural grassland have been ploughed for crop production. The possibilities of a continued and relentless process of land deterioration are involved. Proper land use can prevent these, but are men prepared and organized to apply the available knowledges regarding the correct utilization and long-term protection of productive soils? One is reminded of the farmer who was not doing right by his land and was urged to go to a meeting on methods of soil conservation. 'There's no use my going to that meeting about farming better,' he said. 'I don't

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farm as good as I know how to now.' The final test for the United States of America, a crisis yet to be met, is whether the national attitude will be similar to that of the farmer, or will they have the foresight and intelligence to act before they are met with the disaster that is steadily drawing nearer?

A detailed presentation of what has happened area by area would fill many volumes. A large amount of precise information has been gathered together by various governmental services, by other conservation agencies, and by a handful of individuals whose perception has led them to give attention to an unfolding drama that is as yet visible to so few.

The submission of the following general facts may serve to throw light on what has happened to the land since those bright days when we began to 'conquer the continent'.

The land area of the United States amounts to approximately one billion nine hundred million acres. In its original or natural state about 40 per cent was primeval forest, nearly an equal amount was grass or range lands, the remainder being natural desert or extremely mountainous.

Today the primeval or virgin forest has been so reduced that it covers less than 7 per cent of the entire land area. If to this there are added other forested areas consisting of stands of second- or even third-growth forests, many of which are in poor condition, and if scattered farm woodlands are also included, it is found that the forested areas now aggregate only slightly more than 20 per cent of the total land area of the country. If urban lands, desert and wastelands, and mountaintop areas, are subtracted there is left somewhat over one billion acres which can be roughly

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divided into three categories: farm croplands, farm pasture lands and range-grazing lands.

The situation as to the remaining forests is becoming increasingly serious. Some idea of recent and present trends can be gained from the information contained in the last annual report of the Forest Service of the Federal Government, wherein it is stated that the estimated total stand of saw timber in the country in 1909 was 2,826 billion board feet and that the estimate for the year 1945 totalled only 1,601 billion board feet, indicating that in 36 years the nation's 'woodpile' has been reduced by 44 per cent. The report goes on to state that the drop in volume of standing timber since 1909 has been much greater than these figures indicate. Many kinds of trees which were considered of no value in 1909 are now being used and are included in the 1945 estimate. It is significantly pointed out that more than half of the present total saw-timber resource is in what is left of virgin forests and that 96 per cent of the virgin timber is in the Western states. This latter statement is of particular interest in the light of a new and serious kind of threat that will be commented on in a moment.

While the drain on forests for fuel wood, pulp-wood, and manufacturing uses, together with losses resulting from fires, wind and ice storms, damage by insects and tree diseases, is almost being met by each year's growth, the bulk of the forestry industry depends on saw timber. For this purpose the annual drain on the nation's forests approximates 54 billion board feet, while the annual growth is only approximately 35 billion board feet. In other words, the annual loss exceeds growth by more than 50 per cent. It does not take much mathematics to prove that America cannot

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go on this way much longer. They are repeating the errors that, as we have seen, have undermined so many other countries in earlier periods of history.

At this very moment a new body blow is being struck at their forests. This is a triple-threat blow, because a blow at forest reserves is one of synchronized impact upon water sources and fertile soils—as deadly ultimately as any delayed-action bomb. Highly organized minority groups are now engaged in determined attempts to wrest away the public lands of the Western states, and turn these regions to their own uses. Within the boundaries of these public domains lie the extensive grazing lands that help support the cattle industry of the West. These lands are open to use by individual cattle owners at small, in fact, nominal cost. Within these boundaries, too, lie almost all the last great forest reserves. These public lands, in which every American owns a share, lie principally in eleven Western states, namely: Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming.

The public lands came into existence in the earliest days of the nation. They were created as a solution to a vexatious question that arose in the deliberations of the thirteen original states at the time the Union was formed. The small seaboard states insisted that provision be made in the Articles of Confederation to prevent the land-rich states on the Appalachian frontier from expanding their boundaries indefinitely to the west and thus dominating the government. All of the original states at that time agreed to give up their claims to the Western lands and ceded them to the Federal Government. As settlement progressed westward, it was planned that these vast tracts would be

formed into new states with the same rights as enjoyed by the original states. In 1787 the Constitution that was evolved upon this basic understanding became a fundamental of American law. Since that year the United States has been enlarged by a series of acquisitions under treaties with other powers, such as the Louisiana Purchase, the Florida Purchase and the Admission of Texas. That is another story. In all thirty-five states have been carved from the public domain, each of them receiving a gift of land, often of many millions of acres, and yet, as each new state was created, there were retained in the name of the Federal Government, for the benefit of all of the people of the nation, these areas of public lands. During the nineteenth century land appeared to be limitless and few people were at all concerned about how it was used, although even as early as 1836 bills began to appear in Congress to provide some protecting regulations for the lands owned by the government. The proportion of Federal lands remaining as public domain varies in each state, ranging from under 100,000 acres in Iowa to 87 per cent in Nevada. This disparity in the ratio of Federal lands to state and private holdings is one of the reasons for the present controversy. It should not be thought of as a major reason, however. The powerful attacks now being made by small minority groups upon the public lands of the West have one primary motivation and one consuming objective—to exploit the grazing lands and these last forest reserves for every dollar of profit that can be wrung from them. As we have seen in other countries the profit motive, if carried to the extreme, has one certain result—the ultimate death of the land.

The eleven Western states which contain the largest

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proportion of Federal lands have become known as the 'public land states'. In practically all of them either the cattle business or lumbering is the major industry. Use of the public lands by cattle owners has always been permitted and, in turn, permits for controlled cutting in the national forests are regularly granted. These rights have frequently been gained at extremely low cost. The fees paid today by cattle-grazing permittees are to all intents and purposes merely nominal ones. Overgrazing in the public lands reached such an alarming point a number of years ago that legislation known as the Taylor Grazing Act was passed in 1934 to control the abuses. For a while this legislation did some good, but as far as beneficial results today are concerned, this act, which was designed to 'prevent over-grazing and soil deterioration', might almost as well never have been enacted into law. Powerful minority groups of cattlemen now dominate its administration, their representatives comprising the personnel of the advisory boards that were established in each of the cattle-industry states. In effect these boards are not advisory at all but over the years have acquired sufficient power to greatly influence the regulations, as to both the number of cattle that can graze in a region and the fees for grazing rights to be paid by cattle owners, half of which go to the counties in which the land is situated, mainly for the benefit of rural schools, and the other half to the Federal Government.

The manœuvres of the powerful minority groups of livestock men, skilfully supported by their representatives in Congress, have a definite bearing on the preservation of the remaining reserves of forests in the Western states. Having taken over virtual control of the Federal Grazing Service they now are attempting

similarly to control the Forest Service, and, from their point of view, with good reason. The national forests in the Western states contain approximately 135,000,000 acres of land, of which some 80,000,000 acres are now being grazed by cattle or sheep. So far the Forest Service's control of the number of animals permitted to graze in a region has been reasonably effective, although actually there has already been considerable overgrazing in some of the national forests.

But the livestock owners are not satisfied and want more privileges. The game is almost too easy, the methods of getting what they want almost too simple. The Grazing Service was emasculated by Congress's reducing its field service budget to one-third of what was needed to provide proper supervision of the ranges. There's generally more than one way of accomplishing an end! Overgrazing in forested areas is ultimately as damaging to forests, because of soil erosion, as slash cutting for the sawmill. As to the latter, let no American think that certain self-seeking groups in the lumber industry are not out to hack what they can from the public domain. They will pay for the right to cut but they can never pay enough because there are not enough forests left. Heretofore national parks have been held inviolate but even now one of them, the Olympic in the state of Washington, is threatened by legislation pending in Congress that would turn over to exploitation a tract of some 56,000 acres of virgin timber. Wilderness heritages going to the buzz-saw!

The assault now being made upon the public lands finds its expression in a number of bills that have been presented to Congress within the last two or three years. They represent an attack more desperate in its nature than any similar one in the history of the U.S.A.

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The purpose of this proposed legislation is, in the main, to transfer the control of these resources from the Federal Government to the several states, with the implicit danger that thereafter they will fall into the hands of individuals for final liquidation. If any of this proposed legislation were enacted into law it would be the opening wedge; if the assault were generally successful it would irremediably injure a great region whose living natural resources serve as a wellspring to the well-being of our entire nation. Shades of the Mesta!

A consideration of the situation of land resources in the country shows that other than forests there are, as mentioned above, about a billion acres that fall into the three categories of farm croplands, farm pasture lands and open-range grazing lands. Of these, farm croplands are the largest in area, running to approximately 460,000,000 acres. What has happened in regard to these resources and what is going on now?

The most recent report of the Soil Conservation Service of the government contains a number of pertinent statements. They are a factual recital. They point to a velocity of loss of the basic living elements of America which, if continued, will bring about a national catastrophe. Already every American is beginning to be affected in one way or another by what is happening. This report indicates that of the above billion acres considerably more than one-quarter have now been ruined or severely impoverished, and that the remainder are damaged in varying degrees. Furthermore, the damage is continuing on all kinds of land—cropland, grazing land, and pasture land. Here are other highlights in the report:

‘The loss we sustain by this continuing erosion is

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staggering. Careful estimates based on actual measurements indicate that soil losses by erosion from all lands in the United States total 5,400,000,000 tons annually. From farm lands alone, the annual loss is about 3 billion tons, enough to fill a freight train which would girdle the globe 18 times. If these losses were to go on unchecked, the results would be tragic for America and for the world.

‘The results would not only be disastrous—they already are far too costly for the country to continue to bear. For example, in a normal production year, erosion by wind and water removes 21 times as much plant food from the soil as is removed in the crops sold off this land.

‘Nor is loss of plant food our only expense from erosion. The total annual cost to the United States as a result of uncontrolled erosion and water runoff is estimated at \$3,844,000,000. This includes the value of the eroded soil material and the plant nutrients it contains, the direct loss sustained by farmers, and damages caused by floods and erosion to highways, railroads, waterways, and other facilities and resources.

‘The loss in the productive capacity of our farms cannot be figured so easily, but it is plain that farm lands which have lost so much topsoil and plant nutrients cannot produce as bountifully as they did before they were slashed and impoverished by erosion.

‘In that fact lies the significance of America’s erosion problem for America’s citizens. We do not have too much good cropland available for production of our essential food and fibre crops in the future. If we do not protect what we have, and rebuild the land which can still be restored for productive use, the time inevitably will come—as it already has come to some areas of the

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world—when United States farm lands cannot produce enough for us and our descendants to eat and to wear.’

The Soil Conservation Service has only been in existence since 1935. It was created by Congress in that year not so much as a result of the government’s vision or strategy but principally because the people of the country had been struck with dread by the revulsion of nature against man that was evidenced by the Dust Bowl incident on May 12 of the previous year. On that day, it will be recalled, the sun was darkened from the Rocky Mountains to the Atlantic by vast clouds of soil particles borne by the wind from the Great Plains lying in western Kansas, Texas, Oklahoma and eastern New Mexico and Colorado—once an area of fertile grasslands but now denuded by misuse, much of it to the point of permanent desolation. In the years since its inception this government service has gained extraordinary results in advancing the science of proper land use and in assisting soil conservation districts, set up under state law, and encouraging voluntary and cooperative action among farmers. These conservation districts now exist in all the states and have been the medium through which better methods of land use have been adopted in many of the farming regions. At best, however, this vital programme—one of the most elemental that affects the lives of the people of the country—is only well started.

In a book published just before the war dealing with the world problem of erosion the authors state that the United States is more erosion-conscious than any other country and is organizing itself more effectively than other nations to cope with this danger. Compare this observation with the statements just quoted from one of the governmental departments that are attempting

to combat this menace. Attempting to! They have barely made a start. Appropriations of the Federal Government towards conservation purposes of every nature—soils, forests, wild life, water control, reclamation projects and others—are less than 1 per cent of the present national annual budget. While to this should be added moneys spent for conservation by individual states, yet the aggregate of governmental expenditures is but a fraction of what is needed to protect the basic elements of the nation's present and future strength.

It would be a grave error to think that the increasing emergency facing the U.S.A. is one of easy solution. Soil erosion is only one factor in a disturbance of continental magnitude. It is the end-result of other conditions, both physical and economic, and even social and political.

In its physical aspects the battle to control soil erosion will not be won until America has reached the point of protecting its forests so that the annual drain upon them does not exceed their annual growth. A great part of the vast expenditure now being made in flood control will in the years to come be written off as dead loss unless the watersheds are protected both as to adequate forest cover and as to the curbing of erosion in the grasslands and croplands that lie within them. So far the point of synchronized effort has not been reached. Flood-control engineers are not looking upstream. In the Rio Grande watershed in New Mexico, for example, flood control and river development plans are in the making that are estimated to cost more than \$100,000,000, regardless of the need for the establishment of a contemporaneous plan for work upon the eroding and silt-producing lands of the abused watershed. This region has been referred to as

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'the doomed valley, an example of regional suicide'. There are other such critical points—too many. The assault on the public lands of the West, if successful, will breed more.

How about the valley of the greatest river of them all, the Mississippi, its bed so lifted, its waters so choked, so blocked with the wash of productive lands, that the river at flood crests runs high above the streets of New Orleans? As in historical times, the power of nature in revolt will one day overwhelm the bonds that even the most ingenious modern engineer can prepare. It should by now be clear that natural forces cannot be dealt with in this way. And, too, like echoes from the long past, there are discernible among the earlier causes that have brought the Rio Grande Valley to its present difficulties the age-long and disastrous conflict between the herdsman and the agriculturist—echoes from the wasted lands of Asia Minor, of Palestine, of Greece and of Spain. Today the story has different overtones. The raids of the herdsmen of earlier times find their twentieth-century counterpart in the work of political pressure groups representing powerful livestock owners in the halls of Congress. Representatives of the lumber industry are there too, striving to effect arrangements so that the profits of their corporations may be assured and, if possible, increased. There is nothing unethical about all of this under the present scheme of things. For the moment it is the American way of doing business. Now, however, in the light of the provable facts, the use of productive land and renewable resources—forests, wild life and waterways—must be directed solely to the benefit of all the people. Ethics, too, are involved. Under our present criminal code anyone who steals food from a grocery counter

can be put in jail. His act hurts only the proprietor of the store. But if, for the benefit of his own pocketbook, the owner of timberlands at the head of a river strips the hills of their forests, the net result is that food is taken not from one 'proprietor' but from all the 'proprietors', or farm owners, down the valley, because the removal of forest cover on an upper watershed will inevitably damage the water supply in the valley below, even to the point of causing the complete drying-up of wells and springs. Countless thousands of landowners in America have in this very way been brought to bankruptcy. In the face of such things, how equitable are present moral codes?

There is nothing revolutionary in the concept that renewable resources are the property of all the people and, therefore, that land use must be co-ordinated into an over-all plan. This principle has been recognized in other democracies. In several countries in western Europe, for example, an individual owning forests can under no circumstances cut down a tree on his property unless such cutting conforms with the principles of sound forest treatment as prescribed by the Forestry Department of his government. In effect, private ownership of the country's resources is countenanced only if the use of such resources is directed towards the interests of the people as a whole.

The United States has, within the last decade, begun to move in this direction. The first step of co-ordinating land resources into a unified programme found expression in the Tennessee Valley Authority created by Congress, after much heart searching, in 1933. This enterprise, conceived in accordance with the American slogan 'When you do something, do it big', is an experiment in the unified planning and development of a

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great river valley and of its water and land resources. It directly affects the lives and fortunes of more than 3,000,000 people. Aply administered, it has, within the span of little more than a decade, justified itself not only as a social experiment but as an effort to harmonize human needs with the processes of nature. Above all, it provides an example from which lessons can be drawn for the solution of the problem that faces the entire country. The interdependence of all the elements in the creative machinery of nature points clearly to the fact that any programme devised to meet the situation calls for a supreme co-ordinated nationwide effort. Many conditions are involved—social, financial, political, as well as physical. Such a programme still is awaiting formulation.

The question remains. Are the United States of America to continue on the same dusty perilous road once travelled to its dead end by other mighty and splendid nations, or, in their wisdom, are they going to choose the only route that does not lead to the disaster that has already befallen so many other peoples of the earth?

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Custom would demand that anyone who holds views such as those here expressed should, in conclusion, do one of two things—either suggest a programme for saving the situation or, admitting its hopelessness, resignedly express the belief that we are moving towards the twilight of civilization. These pages, however, are intended only as an expression of a theory concerning the relationship between human life and the living world that lies around us. The impulse to write this brief book sprang from the conviction that we human beings were rushing forward unthinkingly through days of incredible accomplishment, of glory and of tragedy, our eyes seeking the stars—or fixed too often upon each other in hatred and conflict—and that we had forgotten the earth, forgotten it in the sense that we were failing to regard it as the source of our life. It is amazing how far one has to travel to find a person, even among those most widely informed, who is aware of the processes of mounting destruction that we are inflicting upon our life sources. The few who realize this fatal fact do not, as a rule, associate it with the vast surges and pressures of increasing populations. These are conditions that need to be thought of together, not separately. Then, too, how limited in number are those people, the specialists, people of wonderful and intimate knowledges, whether in the sciences of agronomy, or chemistry, or biology, or economics or politics, who recognize that their special knowledges can only be of maximum utility if they are integrated one with the others? These observations have the

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horrid sound that might come from a man who thought he had some special comprehension of how society should operate and even of the paradox of human life. Actually, whatever value may rest within these pages will be derived not from special knowledges but from the perspective that may come from the lack of them. It has been my intention consequently to do no more than attempt to present a synthesis of some of the biological and historical facts of human existence. Therefore, while custom may make its demand that this discussion must end with either a programme or a prophecy, others far more competent will have to formulate the programme, or others, more audacious, grasp the right to prophesy.

Having thus endeavoured to clear my own conscience from attempting what perhaps would be beyond the capacities of any individual, there still can be expressed a few observations concerning a situation that must be dealt with if human civilization is to survive. There would seem to be no real hope for the future unless we are prepared to accept the concept that man, like all other living things, is a part of one great biological scheme. There are those who will deny this just as the leaders and peoples of vanished nations have failed to recognize this truth in the past. Today, almost every purpose and activity of modern life takes precedence over the one most basic purpose of all, namely that of conserving the living resources of the earth. There is a growing consciousness that all is not well, and a stirring and uneasiness in numerous countries where at least initial steps are being taken to cope with the problem. At best there is a mere beginning.

In my own country there are now real grounds for hope. Within the last decade more has been accom-

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plished than in all the previous years of our history. Federal and state agencies are steadily doing more effective work and unlimited credit should be given to the able and intelligent men who are accomplishing everything within their power to save America for its future children. Yet under the pressure of a growing population, of industrial demands and of world responsibilities, we have not even begun to strike a balance in preserving the living assets of the country.

Evidence that conservation work still plays an extremely minor part in the activities of our Federal Government is found in the fact that less than 1 per cent of the annual national budget is spent for this purpose. While state governments also expend funds for conservation work, the sum total of expenditures from all governmental sources is but a fractional part of that demanded by the urgency of the situation. One may well ask, Why should government do it? Theoretically, in a land of free enterprises, the responsibility should rest upon individual initiative, but this can only be counted upon when there is general public understanding of a situation and of the means of dealing with it. This knowledge is lacking in the urban population which comprises considerably more than half of the people. In the rural populations there is, fortunately, a growing consciousness that the productivity of the land is threatened and increasing knowledge of the steps that must be taken to avert this peril. This promising trend is due largely to the movement initiated by the government only as recently as 1935 that provided for the establishment of so-called Conservation Districts. This movement has gained substantial momentum so that by now all the states have enacted legislation whereby through self-governed and

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co-operative district planning, effective procedures of land use are being put into practice. As yet, however, a relatively small part of our productive land is sufficiently well organized and, further, this movement is directed primarily at conserving fertile topsoil in the agricultural districts.

Our forests are still being depleted at a rate far in excess of their annual growth and as a result water sources, wild life and the other interrelated elements of nature's economy are still being dangerously affected. As an example of the continuing trend of things there have of late been presented to Congress a series of bills which, if enacted into law, could only result in irreparable injury to the grazing lands and the remaining reserves of virgin forests that lie within the public lands of the Western states. Within these regions are the watersheds of such great river systems as the Rio Grande and the Colorado, whose waters make life possible for millions of people as far away as Texas and California. We are still riding the downward spiral that has carried other nations to eclipse and even to oblivion.

Action of government, in the last analysis, rests mainly, of course, on the point of view of the people. The fact that more than 55 per cent of the population of the U.S.A. live in cities and towns results inevitably in detachment from the land and apathy as to how living resources are treated. As a result the majority of voters in the United States at this time neither know nor care about the problem that is facing them. As a consequence, elected representatives of the majority of the people are likewise apathetic.

This great section of the people of the U.S.A., as well as large portions of the rural population, either do not realize what is going on or are lulled into a false

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sense of security by misleading reports regarding the status of their life-supporting resources that are inspired by groups having special interests in such properties as timberlands, cattle and water rights. Probably, however, the most potent soporific affecting popular opinion comes from the belief we all innately share these days to the effect that the marvels of modern technology can solve any of the riddles of life. The miraculous succession of modern inventions has so profoundly affected our thinking as well as our everyday life that it is difficult for us to conceive that the ingenuity of man will not be able to solve the final riddle—that of gaining a subsistence from the earth. The grand and ultimate illusion would be that man could provide a substitute for the elemental workings of nature.

It will be recalled that the U.S.A. as a whole became seriously alarmed, and converted alarm into action, after that dramatic day when the dust clouds from the Far West hid the sun from the Capitol in Washington and darkened the Eastern cities. Do we need another catastrophic warning from nature to stir us to further action, or can we not now accept the many evidences of approaching crisis and take steps to ward it off? Only a great nationwide effort can give assurance for the future. It will involve complete co-operation on the part of both government and industry, backed by the public's insistence that the job shall be done. Any way one looks at it a tremendous task lies ahead, probably the most difficult phase of it being that of arousing public opinion as a whole. This will take the co-ordinated effort of every group, governmental and private, that is dedicated to the cause of conservation. From the long-term point of view processes should be estab-

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lished throughout our educational system so that coming generations will grow up aware of the situation that lies at the root of the well-being of the nation. It is extraordinary that with a few exceptions there is no such thing as the general teaching of conservation in our schools and colleges today. The study of history would be illuminated if emphasis were placed on the fact that conditions resulting from man's misuse of his natural living resources were definite factors in the movements of peoples, and in the origins of wars. Likewise courses in economics, engineering, chemistry, biology, sociology and even philosophy would be vitalized if they included considerations of man's relationships to the natural physical world in which he lives.

Finally, when will the truth come out into the light in international affairs? When will it be openly recognized that one of the principal causes of the aggressive attitudes of individual nations and of much of the present discord among groups of nations is traceable to diminishing productive lands and to increasing population pressures? Every country, all the world, is met with the threat of an oncoming crisis. The time for generalizations, such as the third of the Four Freedoms, is over. 'Freedom from Want' is an illusory hope unless its pronouncement is coupled with a statement that clearly sets forth the present problem, so that all peoples everywhere may join in common endeavour to resolve it. The tide of the earth's population is rising, the reservoir of the earth's living resources is falling. Technologists may outdo themselves in the creation of artificial substitutes for natural subsistence, and new areas, such as those in tropical or subtropical regions, may be adapted to human use, but even such recourses or developments cannot be expected to offset the

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present terrific attack upon the natural life-giving elements of the earth. There is only one solution: Man must recognize the necessity of co-operating with nature. He must temper his demands and use and conserve the natural living resources of this earth in a manner that alone can provide for the continuation of his civilization. The final answer is to be found only through comprehension of the enduring processes of nature. The time for defiance is at an end.

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F. O.

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