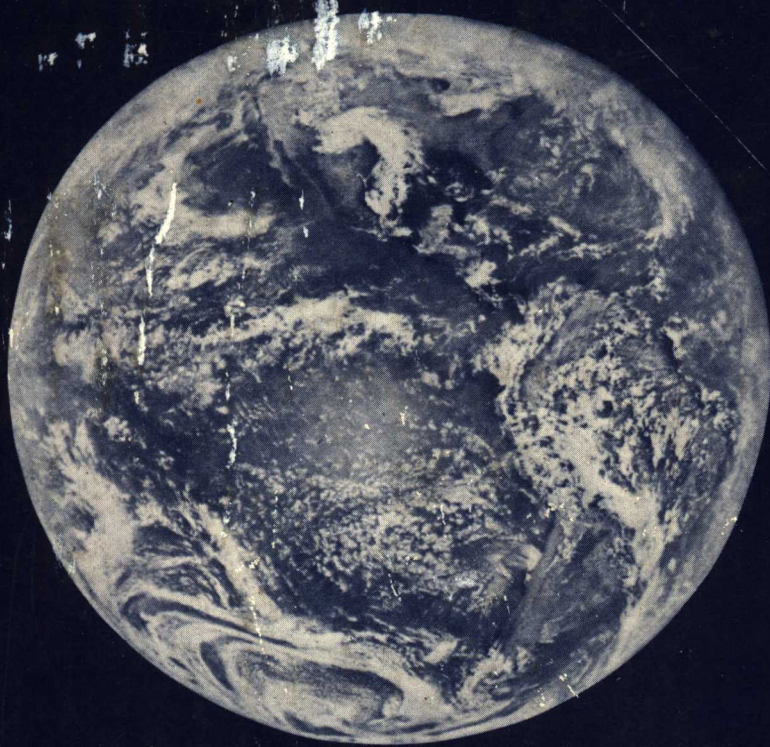


Ark II

SOCIAL RESPONSE TO ENVIRONMENTAL IMPERATIVES

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Prologue

Noah had ample warning from a respected authority to build his Ark, and he used his time to good advantage.

Skeptics laughed, ridiculed, and drowned—but Noah,
the original prophet of doom, survived.

We too have been warned that a flood of problems now threatens the persistence of industrial society, but this time the ark cannot be built out of wood and caulking. We must ensure our survival by redesigning the political, economic, and social institutions of industrial society. If a new institutional ark cannot be made watertight in time, industrial society will sink, dragging under prophets of doom as well as skeptics and critics.

Introduction

Something is happening to the great American dream. Even though large wage increases were won by American workers in the late sixties and early seventies, these increases have been cancelled out by rampant inflation. Wage earners who hold so-called good jobs feel that they may no longer be getting ahead in life and that American society faces a dim and uncertain future. What difference do pay increases make when the costs of housing, food, electricity, and gasoline rise just as rapidly or more rapidly than wages and salaries?

Many people realize that other, seemingly distant, occurrences are having a serious impact on their lives. They know, for example, that economic conditions had so deteriorated by 1971 that a Republican President, supposedly a stalwart defender of the free enterprise system, found it necessary to freeze wages and prices. Even though the freeze was ineffective, the President proclaimed it a success and removed most wage and price controls in 1973. Quite predictably, prices shot up astronomically. Many have also perceived that the "trickle down" theory, which holds that when times are good for business the profits trickle down to the working man, has little validity. In 1972, when the working man was told to forego wage increases in the interest of economic stability, many corporations reported record or near record earnings.

Americans fortunate enough to be able to travel abroad have also been particularly aware of unusual events. They realize, sometimes very acutely, that the once sound dollar, the currency of the world's strongest economy, has been considerably devalued. Airline fares, hotel and restaurant bills, souvenirs, and all the other things for which tourists pay now cost much more than they did

in the very recent past. At home, the prices of imported items, ranging from Japanese automobiles to French wines, have been climbing out of sight.

But not all of the problems with the American dream are purely economic. Many people are rightfully confused about recent and not so recent political events. Some lost their sons in Vietnam for a cause that was not a cause against an enemy that was not really an enemy. Although very few people actively seemed to support this intervention in Asian affairs thousands of miles from home, the war ground on for more than a decade. In 1964 millions of Americans, tired of war, voted for what they thought was a peace-loving candidate. Lyndon Johnson spent four years escalating this distant war that was irrelevant to America's pressing problems, and voters—fed up with the Democrat's war—switched allegiances in droves. In 1968 they voted for a Republican candidate with a "secret peace plan." This President then spent another four years fighting the same war.

In the end, the methodical use of American airpower and advanced technology gained a cease-fire and an opportunity to escape from the lengthy embroilment. No one seemed very happy with this dubious kind of victory. The inconsistencies in Vietnam policy and the obvious propaganda that came from the White House drove a deeper wedge between elected officials and the majority of voters. People wondered why the South Vietnamese, who presumably were fighting for their freedom, were unable to beat a greatly outnumbered and outgunned enemy.

Closer to home, the Watergate scandal has shaken what little public confidence in political leaders still existed. It has been difficult for Americans to reconcile burglary, poll-rigging, illegal campaign contributions, and an Attorney General who apparently condoned various crimes, with the textbook image of the American political process. The nagging feeling lingers that this is only the tip of an iceberg that extends down through the political process at all levels.

Many Americans also have become upset and even angered by environmentalists and population experts who are predicting disaster. Much of what is said is remote from daily experience and very hard to believe, but other comments do seem to make sense. Most Americans have always thought that economic growth and improvement were synonymous, although now some of these experts claim that certain types of growth are bad. The Bible admonishes man to be fruitful and multiply, but numerous scientists claim that the planet is overpopulated, that huge famines may occur soon, and that population control is vital to a prosperous future. Scientists also say that pollution is gradually killing people, that a real energy crisis is imminent, that

nuclear power plants are potentially dangerous, that pollution may alter climates and lead to crop failures, and that, in general, society is not coping with its most pressing problems.

This nagging discomfort is enhanced by evidence that the environmentalists might be right. Air and water pollution are becoming increasingly evident, as is the press of growing numbers of people. Food prices are skyrocketing, which suggests growing scarcity, and reports of food shortages appear more and more on the evening news and in the press. Furthermore, while Arab leaders threaten to withhold petroleum exports for political purposes, many Americans find their gas tanks already empty and no one able to fill them.

What cuts right to the heart of the American dream is that, because of these and similar problems, it seems likely that life will be tougher, rather than easier, for everyone's children. Most people are just beginning to learn about exponential growth, resource depletion, and environmental deterioration, and they know that these once unfamiliar phrases mean trouble for their offspring. Most Americans are willing to break their backs so that their children will have a chance to get ahead, get a higher education, and enjoy some of the good things in life. That is why it is so difficult to come to terms with prognostications that indicate these dreams may never be realized.

Americans, however, are not a passive people, and many millions have been expressing their numerous discontents at the ballot box, in letters to the editor, and in massive demonstrations that were seldom seen in the United States before the sixties. Many active and concerned citizens are willing to face these problems and want to learn more about them. More important, some have begun looking for solutions.

The environmental crises that confront twentieth-century America are not insoluble, but neither are they problems that can be swept under the rug by simply investing more billions in research and development. They are complex and interlinked problems that have hidden social roots. These roots have been ignored by most people because to admit that they are part of the problem means considering the alteration of institutions, values, and behavior. This is very difficult for most people to do because it usually means shaking cherished beliefs and perhaps completely changing the view of the world that is shared with friends and relatives.

In attempting to outline the complex of socioenvironmental problems and the type of social transformation that will be required to solve them, we are beginning a very difficult task. Ramifications of all these problems surface daily, and no two people can begin to know all the solutions. But we have

become convinced that the time has come for people to start searching for comprehensive, rather than piecemeal, solutions. To continue to wait for "more complete understanding" or to commission yet another "detailed study" is to guarantee future disaster. The optimism implicit in such books as *The Greening of America* or *Where the Wasteland Ends* lulls people into a false sense of security while problems continue to mount. Such thinking discourages a rational evaluation of what is taking place in American society and leads to little in the way of concrete programs for change. There are few data to indicate that present industrial society, with all its suicidal tendencies, has begun significantly to transform itself. If anything, decisions made in the last few years have been setbacks for those programs and proposals that could lead society in new directions. Decision makers are daily committing serious errors as they attempt to hold the old system together with patchwork solutions and avoid making any major changes that would affect the nation's numerous vested interests.

We have tried to write a book that is useful on two levels. We believe it is essential to present our case in language that people can understand. Professional jargon only serves to confuse the nonspecialist and to insulate the specialist from possible criticism. We hope that we have succeeded in using language that can be easily understood, because necessary political action requires the support of an electorate that appreciates the dimensions of the crisis that must be faced. On another level, we have tried to make the book useful to those who wish to read further about particular problems by providing notes and a suggested reading list at the end of the book.

After analyzing available data we have concluded that it is time for humanity to begin risking some mistakes to move toward a more promising and viable way of life. To sit and wait, hoping that old values will see us through, is to make the biggest of all mistakes. We know that the old system will not hold together much longer, but fear may cause us to bury our heads rather than face an uncertain future. In the spirit of looking for social solutions that may help meet impending crises, we make no apologies for any of the suggestions that appear in *Ark II* that might prove to have unforeseen ramifications. We are not wed to any of them and think that they have been made in the best of all causes—initiating a debate on social alternatives. We are certainly ready to change our minds when our suppositions are shown to be wrong or when more viable alternatives to our proposals are suggested. But we feel that to hesitate to make judgments and suggest solutions in fear of error is to abdicate responsibility in the face of certain crisis. In short, we can stand the heat and have no intention of leaving the kitchen.

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I

The Rising Tide

Today nearly four billion people inhabit the Earth. Human activities currently move much larger quantities of iron, phosphorus, nitrogen, mercury, copper, zinc, and many other minerals than do the rivers of the planet, inject more sulphur into the atmosphere than do volcanoes, and add twenty times more oil to the oceans than do natural processes. *Homo sapiens*, just one of perhaps five million species of animals, has set up agricultural systems within which approximately one-twentieth of net global photosynthetic productivity occurs. By any number of measures mankind has become a truly global force.

It is tempting to say, "So what?" Why should we worry if mankind increases, multiplies, and exercises dominion over the planet? Is not the damage inflicted on the natural systems of the Earth a small price to pay for progress? Unfortunately, the larger the scale of human activities, the larger will be the consequences of human mistakes. To date there is little evidence that mankind is intellectually, emotionally, or socially prepared to assume stewardship of the Earth's ecosystems or to guarantee the continuation of

their essential functions through the planning and restraint that are needed to avoid serious mistakes.*

At this very moment, mankind is escalating its attack on the life-support systems of the Earth at a rate that will double human impact every fourteen years. Thus, if the level of environmental deterioration observed at the time of the first Earth Day in 1970 was symptomatic of the stressing of ecological systems halfway to their breaking point, ecological collapse and the end of industrial civilization could occur in 1984. More optimistically, if those systems can take fifty times the level of abuse of 1970 before they disintegrate, then industrial society cannot survive past the middle of the next century, unless the rate of human attack on nature is slowed. The social, economic, and political changes required to slow that assault are the subject of *Ark II*.

Three Revolutions

There have been three "revolutions" that have profoundly changed mankind's relationship to the ecological systems of the Earth. The first, the cultural revolution, occurred more than one million years ago. It began with the development of language and a complex culture. By banding together on the hunt, dividing labor, perfecting diverse tools, and cooperating for defense, primitive man slowly gained a more secure life and the human death rate began to fall. There were no dramatic increases in numbers at this early stage. But even though the population increased very slowly at first, the trend that culminated in the extremely rapid growth rates of the twentieth century had already begun.

* A *population* is a group of individuals of the same *species* of organism; for instance, a flock of ducks or all the human beings on Manhattan Island. All the individuals of different populations living in a given area make up a *community*. A community, taken together with its nonliving physical environment, is known as an ecological system, or an *ecosystem*. The term ecosystem is used when it seems desirable to emphasize the physical, chemical, and biological relationships that bind communities and their physical surroundings into more or less functional units. The ecosystems of the world are linked by movements of energy, chemicals, and organisms into one global ecosystem, often called the *biosphere* or *ecosphere*. Photosynthesis is the process by which green plants convert the sun's energy into chemical energy that can be utilized by themselves and by animals. The rate of energy thus converted is the *gross productivity* of an area; primary productivity minus the energy used by the plants for their own activities is *net productivity*. Productivity may also be viewed in terms of the organic matter created in a given area over a given period.

At the beginning of the second great transformation—the agricultural revolution, which began around 8000 B.C.—there were only about five million people on the Earth. The agricultural revolution occurred when some groups gave up their nomadic hunting and food-gathering way of life, settled down, and began to farm the land. This development accelerated population growth by leading to a further decrease in the death rate. More dependable food supplies reduced the incidence of starvation and encouraged the construction of permanent settlements. There was no longer a need to travel continuously in search of food, since most nutritional needs could be met by farming. Moreover, fields and stock required constant care, effectively keeping the farmer in one place. Permanence made it possible to store food against times of shortage, further reducing the chance of starvation.

Eventually, agricultural productivity reached the point where it could support a substantial nonfarming population. Cities were thus born of the abundance created by more efficient agricultural methods. Within the newly formed cities, further divisions of labor took place, and mankind started down the path toward today's interdependent and complex industrial societies. Following the agricultural revolution, the human population increased well past the point where a return to primitive hunting and gathering was possible. Most societies quickly became dependent on agricultural technology instead of the productivity of natural ecosystems. Man had not only learned to coax greater productivity from Nature, he had also become dependent on manipulations of the ecosphere to ensure continued survival. Those manipulations began to change the character of the Earth's ecological systems, thus commencing a trend toward widespread environmental deterioration.

Approximately 10,000 years elapsed between the beginning of the agricultural revolution and the industrial revolution that succeeded it. The world population grew at a modest rate during most of this period, and by 1650 it was approximately 500 million. Then the pattern of rapidly accelerating population growth began. At first it apparently was a response to improvements in agriculture and sanitation and perhaps to the opening of the western hemisphere to colonization. Then a third great revolution in the history of humanity began to transform the world. In only 200 years the population doubled. By 1850 there were one billion human beings, and human activities began to assume global ecological importance. The population doubled again within only eighty years; by 1930 the Earth was inhabited by two billion people, and the population was growing at such a rate that it would double in only forty-five years.

The industrial revolution was made possible by the harnessing of inanimate energy and the making of further refinements in the division of labor. Production and consumption of goods accelerated at a very rapid rate. Before the industrial revolution, goods were produced on a small scale, mainly by the energy of man and beast. But the harnessing of inanimate energy—first wind and water and later fossil fuels—made available the vast quantities of energy necessary to sustain large-scale production in an increasingly complex industrial society. Factory production provided material abundance unknown to previous generations. Superficially, it appeared to render mankind less and less dependent on Nature, although the industrial revolution generated side effects that have only recently been recognized as threatening to mankind's future.

Each of the three major revolutions did much more than simply augment human numbers and make life a little easier. The new technologies that evolved in each of the major revolutionary steps increased the human impact on the natural systems that are crucial to mankind's survival. Greater numbers, *combined with* these new technologies, have led to increasing deterioration of the environment. Today, the industrial countries are entirely dependent on an industrial technology that is largely sustained by burning fossil fuels and utilizing other nonrenewable resources. Advocates of uncontrolled growth would increase this dependence even further. Yet rapidly increasing consumption of fossil fuels and minerals cannot long continue, given the Earth's limited supplies of these resources.

Perhaps most important, during each of the three revolutions, changes in material abundance, as well as changes in technology and methods of production, have been reflected in shifts in the norms, values, and institutions that shape and guide human behavior. This is why, when viewed as a whole, each of these periods of transition can properly be called a revolution. The cultural revolution led to the early development of shared values and social institutions. The agricultural revolution led to the formation of cities and urban cultures. The industrial revolution accelerated urban growth and led to a society that is increasingly dependent on technological development and oriented toward production of material goods.

During the extended course of each of these major transformations, the motivation for change came from the obvious advantages of new technologies. Those early human groups that best learned to cooperate and communicate soon surpassed other bands. Those peoples who learned to domesticate plants and animals had a higher survival rate than those still dependent on hunting and gathering for their food. Those societies that

initially embraced the industrial revolution did so because of obvious material benefits. Industrial cultures have easily displaced primitive hunting and gathering tribes and subsistence agricultural societies. During each major shift, institutions, norms, and values were altered in response to new discoveries that led to obvious improvements in the standard of living.

The Assault on Nature

Humanity's first great impact on Nature resulted from the mastery of fire. By accident at first, and later by design in hunting and gathering, fire was used as a tool. As a consequence, substantial areas of the Earth were converted into "anthropogenic savannahs" (areas made nearly treeless by man) by repeated burnings. The technology of preagricultural people not only altered plant life, it also had a substantial impact on animal life. Part of this impact was an indirect result of the change in the nature of the plant life available for foraging. The rest of the impact, however, was more direct. A currently held theory is that, as primitive hunters became more skilled at the chase, numerous species of animals were hunted to extinction. This trend has continued, and today the survival of many animals is jeopardized by direct and indirect human impact on natural ecosystems.

It was, however, only with the beginning of the agricultural revolution that mankind moved along a path leading directly to today's serious threats to the ecosphere. Agriculture, by its very nature, replaces complex ecosystems with simple ones, a process that leads to ecological instability. When land is cleared for farming, woodlands and grasslands containing many types of plants and animals are removed and are replaced by crops, often with the result that only one kind of plant is grown over large areas. Thus, enormously complex tropical rain forests are replaced by patches of corn or taro, or species-rich prairies are plowed under to make way for thousands of square miles of wheat.

In the early days of agriculture, the simple ecosystems created by men were minuscule in comparison with the complex natural systems of the Earth. People made mistakes in their farming practices and caused small-scale disasters, but these were usually local in nature. A classic example is the conversion of the lush Tigris and Euphrates valleys into desert as a result of faulty irrigation practices. As the spread of agriculture permitted world population to increase, more and more land was planted in crops, and human dependence on technology and the deterioration of the environment in-

creased apace. Interactions became more complex, and destructive activities often reinforced each other. Agriculture permitted dense urban populations, but urbanization required wood for building and fuel. Centers of civilization soon became conspicuous by their deforestation. Loss of forests changed climates, altered watersheds, and increased erosion of soil by wind and water.

Any monoculture (an extensive stand of a single kind of plant, such as a large cornfield) is highly vulnerable to plant pests and diseases. An insect pest, a fungus, or a strain of bacteria can sweep through the entire plant population. A classic example of the destruction of a monoculture is provided by one of the first "green revolutions," the introduction of the potato in Ireland in the eighteenth century. The potato provided the basis for an increase in the Irish population from three million people living in poverty to some eight million living in poverty. In such situations, expansion of the food supply does not necessarily lead to an increase in the standard of living; more frequently, it leads only to more people living at the same low standards. A major disaster occurred in Ireland between 1845 and 1848. The unstable potato ecosystem collapsed and with it the artificially augmented carrying capacity of the land. A fungal blight invaded the fields and destroyed most of the crop, producing one of history's great disasters—the Irish Potato Famine. In a four-year period, some 1.5 million people starved to death, 2.0 million emigrated, and millions of others underwent great suffering through semi-starvation.

Today much more is known about plant diseases than was known in the middle of the last century, and agricultural geneticists are continually attempting to breed new crop strains that are resistant to various plagues and pests. The organisms that attack the crops, however, are also continually evolving new strains that can attack previously resistant crops. In 1970, for example, a major portion of the corn crop in the United States was threatened by a blight that successfully attacked the most commonly planted hybrid strains.

The great productivity of twentieth-century agriculture has been based on the successes of plant breeding technology, but these genetic triumphs have not been accomplished without cost. High yields have often been bought at the price of lowered resistance to pests and diseases. Most important, the success of the new strains poses a subtle but lethal danger, stemming from the unwillingness of "economic men" to plant strains that produce less than the best crop yield. Farmers eagerly embrace new high-yielding varieties, and as a result larger and larger areas are being planted in single strains. Monocultures are thus becoming both more extensive and more uniform. Traditional

strains of staple crops are rapidly being wiped out. Today only traces of the former diversity can be found where even a few decades ago numerous ancient strains of wheat and barley were commonly grown.

The loss of genetic diversity from which new strains can be developed represents the ultimate simplification of agricultural ecosystems. It is also a one-way street. Once genetic diversity is lost, there is no practical way to restore it. Genetic diversity is essential if plant breeders are to stay ahead in the "evolutionary race" that they are running with the insects and microorganisms that attack crops. Unless crop diversity is preserved, mankind might soon be plagued by sporadic destruction of sizable portions of its agricultural harvest, and the resultant famines could make the Irish Potato Famine pale by comparison. Eventually the ability to practice high-yield agriculture would be lost; and high-yield agriculture is vital to the maintenance of a human population numbering in the billions. High-yield agriculture exists and can be maintained *only* by the work of plant geneticists, and their *essential* raw material is genetic variability in plants.

Much has been made of the contemporary green revolution, a transformation of traditional agriculture in the less-developed countries (LDCs) by the introduction of high-yielding "miracle" grains. The green revolution represents just one more escalation of the destructive human impact on the life-sustaining ecological systems of the planet. Not only is it built around a limited array of miracle strains, with the attendant problems of monocultures and genetic simplification, but it is heavily dependent on irrigation, fertilizers, and pesticides for optimal production. All of these contribute to environmental deterioration.

Irrigation almost always leads to deterioration of the soil through salting, silting, or both. Phosphate and nitrogen fertilizers run off the fields to which they are applied and into streams and lakes. The streams and lakes then undergo processes of eutrophication (overfertilization). Huge blooms of algae occur and then decay. The decay process consumes oxygen, reducing the capacity of affected bodies of water to support many valuable food fish and to assimilate wastes. There is also, of necessity, a heavy investment in pesticides, since the new strains of plants often show little resistance to insects and other pest organisms. Like fertilizers, pesticides do not stay in one place. Persistent ones move into the soil and streams, are absorbed by various organisms, and become concentrated in food chains. Human beings are exposed to them directly and consume them with their food. Pesticides represent complex and as yet little understood threats both to human health and to the health of natural ecosystems on which humanity depends for its existence.

Aside from direct agricultural assaults on the ecosphere, other technological developments have been slowly chipping away at the resource base that sustains industrial societies. Throughout history, civilization has required an increasing amount of energy. Before industrialization, the vast majority of energy used was derived from current solar "income." Like all other animals, human beings were and are ultimately dependent on the life processes of green plants to convert solar energy into the chemical energy of proteins, fats, and carbohydrates. People then obtain this energy second hand by eating plants, or third or fourth hand by eating animals. Thus, in a sense, all flesh is grass.

In the centuries before the industrial revolution, mankind utilized some solar energy from sources other than food. Energy was extracted from the wind, which was derived from the uneven heating of the Earth's surface by the sun. Energy was also extracted from running water, a source that traces to the evaporation and transport of water from oceans to highlands by the action of sun and wind. And, of course, wood was burned, a process releasing as heat solar energy that the trees had converted to chemical energy.

With the advent of industrialization, people increasingly turned from solar income to a stock of solar "savings" for their energy. Only a small proportion of plant life has ever been directly utilized by animals. Much early vegetation containing stored solar energy sank into swamps where conditions prevented decay. Over millions of years this material became highly compressed and was converted to fossil fuels, such as peat, coal, oil, and natural gas. Eventually, the secrets of these fossil fuels buried in the Earth were discovered. Released from near total dependence on current solar inputs for energy, civilization began supporting its activities by using ever larger quantities of previously stored solar energy through the burning of fossil fuels. This fossil fuel subsidy is essential to today's complex civilization, providing food, warmth, transportation, and conveniences for many times the number of people that could exist within the energy constraints of naturally occurring ecosystems. But this stored energy, which once seemed so abundant, is being rapidly depleted by the demands of modern industry.

In contrast to yesterday's primitive farmers, today's agribusiness complex depends on the ability of each farmer to till hundreds of times the amount of land that could have been cleared and tilled by his predecessors. Modern agriculture is, like the rest of industrial society, heavily dependent on an energy subsidy from fossil fuel. Ecologist H. T. Odum expressed this idea as follows: "Industrial man no longer eats potatoes made from solar energy; now he eats potatoes partly made of oil." The number of calories of fossil fuel energy needed to grow an acre of wheat in Kansas is of the same order of magnitude as the number of food calories in an acre of wheat when harvested.