

## PREFACE

**0.1** First, a few words about the title. One common meaning of the term ‘unearth’ is “to disclose” or “to reveal.” This study is intended, among other things, to reveal the basic source of our current environmental crisis. Another standard meaning is “to extract” or “to eradicate.” It is very much to be hoped that when its roots are eradicated, the crisis itself will wither and become less urgent.

A less common sense of ‘unearthed’ is to be deprived of earthly existence. This study joins ranks with an increasing number of recent studies in concluding that our present crisis is severe enough to threaten the very existence of human society as we know it. For human society to be unseated from its place on earth would be a calamity of unparalleled proportion.

Humanity occupies a unique place in the universe. Among other distinctive features, human beings are capable of wonder and understanding. Once humanity appeared in its midst, the universe could be wondered at and at least partly understood. In a manner of speaking, humanity renders the universe capable of self-understanding, insofar as a part is capable of understanding the whole.

It so happens that human beings are also the most destructive creatures on earth. Both individually and as a species, humans are even capable of destroying themselves. If only a small portion of the world’s stock of atomic weapons were detonated, most of the biosphere would be destroyed along with the humans living in it.

Another, more insidious, threat of self-destruction has begun to take shape in recent decades. At first recognized only by a few far-sighted ecologists, the threat has now come into the limelight under the aspect of global warming. Although climate change is only part of the problem, it helps us comprehend the nature of the underlying

threat. Unless human society changes the way it relates to the environment, we will soon experience catastrophic disruptions of our social existence.

The extensive publicity given global warming obscures other sorts of damage that human industry has imposed upon the biosphere. One such is depletion of the stratospheric ozone layer, allowing dangerous levels of ultraviolet radiation to reach the earth's surface. Although this problem was seriously addressed by the Montreal Protocol of 1987, holes in the ozone layer are still expanding in certain parts of the globe.

Another problem we hear of occasionally is the horrific release of toxins by human industry. These range from heavy metals accumulating in food chains, through synthetic poisons used in agriculture, to lethal wastes retained on the premises of nuclear power plants. Such toxins impose serious threats to the health of human beings, to say nothing of other creatures in the biosphere.

Problems of toxic waste, ozone depletion, and global warming are critical in their own right, and fully worth any effort we can muster to combat them. What has yet to be generally recognized, however, is that these are only particular manifestations of a more fundamental problem—separate tips of the iceberg, so to speak. Even if global warming and the rest were solved independently, this deeper problem would remain unresolved.

Expressed as simply as possible, the fundamental problem is that human economic production activity is generating far more degraded energy than the biosphere can cope with without becoming dysfunctional. If this impairment progresses much further, the biosphere will lose its ability to support human life as we know it.

The reason this more basic problem has gone largely unrecognized is that sciences dealing with the environment lack the vocabulary to express it. Climatology studies global warming, meteorology deals with ozone depletion, and toxicology treats the effects of poisons on living organisms. But even if the respective theories of these disciplines were somehow merged, they still could not articulate the underlying problem.

Given existing divisions among scientific disciplines, ecology seems closest to being up to the task. To describe the problem in its full complexity, however, ecology would have to join with thermodynamics. It would also have to enter territory often claimed by economics. This because economics is the science of production and consumption, which are the activities with which the problem originates.

Let us restate the problem from an economic perspective. Both per capita and species-wide, human beings consume far greater amounts of energy than other creatures. This is due largely to the energy consumed by industrialized economies, both in the production of goods and in their modes of consumption (e.g., use of automobiles). When this energy is used up it does not disappear, but rather is passed on to the biosphere in degraded form.

As matters stand, the biosphere cannot cope with this massive influx of degraded energy, and has reacted by undergoing various forms of degradation itself (e.g., ozone depletion and global warming). The upshot is that the biosphere becomes increasingly unable to support the activities primarily responsible for this excessive load of used-up energy. As human industry discharges ever increasing amounts of degraded energy, the biosphere's ability to support that activity is progressively diminished.

This constitutes the suicidal threat alluded to previously. Industrial activity is part and parcel of human society as we know it. As industrialized economies dump increasing amounts of degraded energy into the biosphere, their very existence becomes increasingly at hazard. At the beginning of the 21st century, this process may already be too far advanced for industrialized society to disengage from its suicidal path. Unless we find other ways of living together that require less energy, human society as we know it seems doomed to extinction.

**0.2** The present study undertakes to describe this predicament in sufficient detail to make it unmistakable to a sympathetic reader. Needless to say, not all potential readers will be sympathetic. To avoid being assailed by epithets like ‘ludite’, ‘nay-sayer’, and ‘prophet of doom’, I have tried to lay out lines of argument that even skeptical readers will feel obligated to take seriously. The general line of argument is summarized in the remainder of this preface.

The central concept of the study is that of *entropy*, which originated in thermodynamics over a century ago and has since been taken over by many other disciplines. As might be expected, use of the concept varies from discipline to discipline. Uses familiar in some contexts will seem mysterious in others.

Chapters 1 and 2 aim at a “normalized” definition of entropy and related concepts, which is to say a definition accessible by each of the various disciplines involved in the study. In one basic form, entropy is energy that has lost its capacity for work. A common example is the low-grade heat generated by the metabolisms of living organisms. Another form of entropy is disorder, illustrated by a collapsed building or a dying tree. The connection between the two forms of entropy lies in the mutual convertibility of their high-grade counterparts. High-grade energy can be used to produce orderly structures (as in the construction of machines and buildings), and orderly structure can generate usable energy (as dams can be used to produce electricity).

Thermodynamics is founded on two fundamental laws of nature. The First Law of Thermodynamics is that the total amount of energy in a closed system (e.g., the total universe) remains constant. The Second Law is that the amount of entropy (degraded energy and disorder) in a closed system tends to increase with time. Taken together the two laws entail that usable energy is constantly being expended and that entropy (useless energy) at the same time is constantly increasing.

These laws deal with measurable quantities. Expended energy is measured in standard units like BTUs and joules. Disorder is measurable in quantities defined in information theory, which has been shown closely related to thermodynamics. The quantities in question are explained in the Appendix to Chapter 2. The main purpose of this appendix is to demonstrate that degrees of order in fact can be measured quantitatively. Readers not concerned with this issue can skip the appendix without losing track of the on-going argument.

With one major exception, all physical processes are marked by an expenditure of usable energy and a corresponding increase in entropy. The major exception is the life-process itself. Chapters 3 and 4 deal with relevant details. An essential feature of a living organism is its ability to extract useful energy and order from its environment, in exchange for the resulting entropy which the environment must somehow get rid of. From the prospect of thermodynamics, life is basically a process of gaining energy and sloughing off the resulting entropy.

A consequence is that life is possible only in environments (i) capable of providing energy in forms and amounts needed to run the metabolisms of resident organisms, and (ii) capable at the same time of carrying off the entropy resulting from this metabolic activity. The more complex the organisms involved, the more entropy they produce for the environment to deal with. As far as we know, human beings are the most complex organisms of all.

At this stage in human development the environment supporting human life extends to the limits of the biosphere itself. This means that the entire biosphere is involved in the interchange between energy and entropy underlying human activity. It also means that human life as we know it can continue only as long as the biosphere is capable of dealing with the entropy that human activity inevitably generates.

For most of its time on Earth, the human race has relied primarily on energy sources that can be renewed as quickly as they are depleted. Most notable among these are various forms of biomass (such as cereals and wood) that are replenished by photosynthesis. Given the adaptive processes involved in a healthy ecosystem, the biosphere generally has been able to rid itself of the entropy produced by its constituent organisms. This is accomplished ultimately by radiation of low-grade heat into space. In effect, the biosphere's ability to discharge used-up energy back into space has remained in balance with its ability to make fresh energy available for use by the life-forms resident within it.

With our growing reliance on fossil fuels over the past few centuries, however, this balance has been radically disrupted. Humankind has begun producing far more entropy than the biosphere is able to get rid of. The problem with fossil fuels is not just that (being nonrenewable) they will eventually be used up; more ominous in the long run is the fact that use of fossil fuels leaves behind residues that clog up the biosphere. The result is not unlike what happens when the sewer backs up in an apartment building. Unless the flow of materials in and out is returned to equilibrium, the building (in our case, the biosphere) becomes unfit for human habitation.

The next two chapters examine the severity of the problem and discuss various forms of entropy build-up in the biosphere since the Industrial Revolution. Chapter 5 points out some of the more obvious forms in which entropy has become impacted within the biosphere. Most widely noted in recent years, to be sure, is the accumulation of low-grade heat known as global warming. Equally pervasive, and no less ominous, are forms of disorder constituting disruptions in the water cycle, the accumulation of toxic substances in our landfills, and the loss of biodiversity in our food-chain. To escape strangulation by the growing glut of entropy being dumped into our environment, we have to do more than cut down on the emission of CO<sub>2</sub> (a major cause of global

warming). In whatever form, we have to stop dumping more entropy into the biosphere than it is capable of handling.

Chapter 6 presents data showing that per capita energy consumption increased in a roughly linear fashion between 10,000 B.C. and the time of the Roman Empire, and then increased more rapidly up to the time of the Industrial Revolution. From that time to the present, per capita energy consumption has been growing exponentially. World population itself has been increasing in a comparable fashion. The result of these two trends acting together is that, whereas total human energy consumption initially doubled every four of five millennia, its average doubling rate during the 20th century was once every 25 years. This amounts to a veritable explosion of human energy consumption.

A corollary of this growth pattern is that there has been a veritable explosion as well in amounts of entropy that human activity has passed off into the biosphere for its disposal. But there has been no corresponding increase in the ability of the biosphere to get rid of this entropy. After scarcely 300 years of heavy reliance on fossil fuel, we have fouled our nest to what may be a point of no return.

This is our environmental crisis in a nutshell. We are consuming energy at rates far exceeding the ability of the biosphere to dispose of the resulting entropy. This puts human society as we know it in jeopardy. The burning question at this point is what can be done about it.

**0.3** The problem stems from the fact that the biosphere is suffering from excessive consumption of energy by human society. To confront the problem realistically, we need to pin down the forms of human activity primarily responsible for this excessive consumption. This brings up the subject of economics.<sup>1</sup>

Chapter 7 explores the link between energy consumption and economic production. Data available from many sources show that these two factors are directly

related. A relevant measure in this regard is the gross product an economy can generate with a given quantity of energy input. In the early 1960s, for example, the U.S. economy produced about a dollar's worth of goods for each 60,000 BTUs (per capita) of energy consumed. Among developing (non-industrialized) countries, Ghana required only 20,000 BTUs for a dollar's production. These figures are part of a set of data showing that developed countries are less productive in terms of energy efficiency. Although the amount of goods they produce is unusually much higher than in developing countries, this is accomplished by consuming prodigious amounts of energy.

A consequence of the coupling of economic production to energy consumption is that volume of entropy discharged increases with volume of economic goods produced. Given that large portions of this entropy currently result in environmental distress (e.g., in global warming), this means that increasing economic production results in progressively greater environmental degradation. A neglected economic principle (one not found in standard textbooks) is that, under current conditions, a given quantity of economic production typically results in a corresponding quantity of environmental degradation.

Given that economic production is the main source of the problem, what should we try to do about it? Any effective remedy will have to reduce the burden of entropy imposed by human enterprise upon the environment. Three possible strategies are (i) repairing environmental damage on a piecemeal basis by innovative technology, (ii) replacing fossil fuel by clean energy, and (iii) reducing economic production to levels the biosphere can tolerate. Strategies (i) and (ii) are discussed in Chapter 8 and 9 respectively. The remaining strategy is examined in Chapters 10, 11, and 12.

An illustration of strategy (i) is the installation of smokestack scrubbers to cut down emissions of greenhouse gases. Inasmuch as many environmental problems stem from industrial technology in the first place, it seems not unreasonable to think they can be solved by technological means. While this approach should be pursued whenever

feasible, however, some environmental problems are too pervasive to admit remedies of this sort. One such is the massive disruption of the planet's water cycle, subjecting increasing numbers of people to conditions of drought and hunger. Although desalination technology (transforming seawater to potable form) can provide relief in isolated cases, shrinkage of fresh water supplies continues unabated in most parts of the globe.

Chapter 9 discusses the alternative of substituting clean energy for fossil fuel. Although several forms of clean energy are currently available, the most highly developed forms are solar and wind power. (In the relevant sense, neither corn-based ethanol nor nuclear power count as clean energy.) While clean energy should be used whenever practicable, this strategy falls far short of providing a panacea. Entropy results from the use of energy in any form, clean energy included. Given that our environmental crisis is a consequence of our producing more entropy than the biosphere can handle, it will not be remedied by substitutions among different forms of energy. Regardless of kind of energy involved, the crisis only worsens as we consume ever increasing amounts of energy.

The remaining strategy goes to the heart of the problem. For the past 250 years or so, industrial economies have been consuming more and more energy at rapidly increasing rates. Entropy resulting from that expenditure of energy is the ultimate source of our present crisis. Strategy (iii) calls for a radical reduction in the amounts of energy we commit to economic production.

This strategy obviously runs counter to the conventional economic doctrine that continued growth is necessary for a healthy economy. If this doctrine is to be trusted, we are confronted by a choice between a healthy economy and a healthy biosphere. Coming to terms with this doctrine is necessary for any workable solution to our environmental

predicament. The last three chapters of Part Two are occupied with a detailed examination of this commitment to economic growth.

Chapter 10 traces the history of the concept of economic growth from the land-based economies of the medieval period, through the mercantile economies in place prior to the Industrial Revolution, up to the classical and neoclassical economies of the past few centuries. The latter era has been marked by an emphasis on the role of the consumer class and the emergence of what came to be known as the free-market system. The chapter concludes with a discussion of neoclassical growth models, leading to the conclusion that neither economic history nor standard growth theory demonstrates that growth is essential to a healthy economy.

Although mainstream economists tend to take the desirability of growth for granted, various arguments are sometimes put forward in its favor. Chapter 11 examines some of the more notable among them. These include arguments relating economic growth to size of population, arguments relating growth to quality of life, and a key argument dealing with the so-called “trickle down” effect. On balance, none of these arguments is sufficiently compelling to show that the alleged social benefits of growth outweigh its costs in terms of environmental degradation.

The main topic of Chapter 12 is a relatively new discipline known as ecological economics (EE). A distinctive feature of this discipline is that it takes issue with the mainstream, arguing against quantitative economic growth in favor of what it sees as qualitative development. Ecological economists typically are sympathetic with the claim that entropy resulting from excessive economic activity is causing severe damage to the biosphere. This encourages a careful look at EE to see what it can contribute to the resolution of our environmental predicament.

Chapter 12 begins by distinguishing between environmental and ecological economics, the former being an offshoot of the mainline variety. Next it traces

antecedents of EE in the economic literature the late 1960s and early 1970s. It then discusses the emergence of EE itself in the late 1980s, and attempts to articulate the values it believes to be embodied in qualitative development. Included are values of justice, equity, and human dignity, along with values of environmental quality.

Advocates of EE sometimes talk of a “paradigm shift” in which their discipline would replace neoclassical economics in the formulation of economic policy. The chapter ends with reasons for thinking that such a shift will not take place. One reason is the EE is too eclectic to come up with a unifying paradigm capable of replacing the mainstream model of the competitive market. Another is that EE lacks the descriptive power of mainstream economics, being less concerned with how markets *actually* operate than with delivering advice (however sensible) on how they *should* operate.

The upshot of Part II for the on-going argument is that mainstream concern for economic growth does not override the imperative that society at large must cut back on its economic production. Strategy (iii) is the only path that leads back to environmental health. Part III addresses the very difficult question of how society might make headway along this path.

**0.4** Part Three is organized around the following considerations. Free-market economies continue to flourish at the expense of continuing environmental degradation.<sup>2</sup> Such economies flourish only in societies where particular sorts of social values are prevalent. Thus one effective way of halting environmental degradation would be to replace the particular values that support free-market economies.

Paramount among such values is the high esteem we assign to wealth. Conditioned by the value society ascribes to wealth, people grow up thinking of wealth as desirable in itself. Chapter 13 argues that desire for wealth is the driving force behind

modern economies generally, and in particular behind economies with a free-market orientation.

The primary beneficiaries of free-market economies are private parties in a position to influence market activity. These include corporate executives, financiers, and investors, along with public officials acting in behalf of private interests. It is desire for wealth on the part of such beneficiaries in particular that provides the impetus toward growth in free-market economies. A similar account could be given of managed (e.g., communist) economies, but with a different list of beneficiaries.

To describe how this works, something needs to be said about the flow of goods in market economies. Generally speaking, goods flow from supplier to consumer while money flows in the opposite direction. Goods are drawn in the former direction by consumer demand, which likewise propels the flow of money back to the supplier. To the extent that these flows can be controlled by interested parties, control is exercised by manipulating consumer demand.

Consumer demand can be manipulated by various forms of marketing. Forms of marketing distinguished in Chapter 13 include product presentation, preference management, and neuromarketing, representing increasingly invasive forms of control over the consumer. Money derived from consumption will be divided among capital investment, taxes, further marketing, and profit, allotted in a manner to maximize profit. Desire for additional wealth thus leads to additional consumption, entailing additional production and ultimately increased damage to the biosphere.

This dynamic has led to gross inequities in the distribution of wealth, both within particular societies and among societies. For example, the average income of the wealthiest one percent in the U.S. at the turn of the century was more than 400,000 times greater than that of one-fifth of the world's total population. The excessive economic

activity that is destroying the biosphere is benefiting only a comparatively small group of privileged individuals.

A common reaction to disparities like this is that they are morally unjust. Chapter 14 examines inequities of this sort through the lenses of environmental ethics. Although it seems antecedently unlikely that our environmental crisis can be resolved by ethical inquiry alone, the insights afforded by environmental ethics might nonetheless prove helpful.

Chapter 14 begins by identifying three moral quandaries with an environmental bearing: (i) whether it is morally acceptable for a few people to maintain lifestyles unavailable to the rest while causing enormous damage to our common biosphere, (ii) whether these few are morally accountable for their wasteful use of resources that might be vital to future generations, and (iii) whether our extensive destruction of other species can be morally justified. The chapter then singles out two ethical perspectives particularly germane to these issues, and proceeds to evaluate their potential contributions.

The first perspective treated is that of utilitarianism, co-founded by the 19th century economist John Stuart Mill. This choice is dictated not only by the economic origin of the quandaries, but also by the similarities between the so-called utilitarian calculus and the cost-benefit analyses employed by mainstream economists. Despite these affinities, however, utilitarianism turns out to be conceptually unprepared to deal with these particular quandaries or with their underlying environmental causes.

Next is the perspective of Aldo Leopold's *A Sand County Almanac*, which has been a dominant force in environmental ethics for the past several decades. Although his so-called "Land Ethic" is not a full-fledged ethical theory like utilitarianism, it has useful things to say about the quandaries in question. Most useful, perhaps, is that contemporary society has no moral guidelines in place pertaining to the interaction

between humanity and the rest of the biosphere. In Leopold's estimation, ecological health depends upon a "durable scale of values" curtailing human activities that are environmentally destructive.

Leopold's perspective reinforces the unifying thesis of Chapter 13, to the effect that our environmental crisis can be traced back to the desire for wealth dominating free-market activities. The value contemporary society places on wealth has no place in a "scale of values" conducive to environmental health. Among other ecologically damaging values indicated in Chapter 13 are those involved in the manipulation of consumer demand. Were it not for a large number of people who value possessions, for example, it would be hard to stimulate consumer demand by standard techniques of marketing.

The perception emerging at this point is that the root cause of our present crisis is not one or another sort of economic activity as such, but rather the pervasive social values that make free-market activity profitable. To the extent that this is so, the remedy would appear to lie in somehow replacing society's current set of ecologically damaging values with others more conducive to environmental health. Here we enter into unexplored territory. How can we tell what values are ecologically damaging? And what can be done to replace these damaging values by others that are ecologically salutary?

These questions set the agenda for the remainder of the study. The first task of Chapter 15 is to explain what it is for a given set of values to be current (in force, in place, immanent) in a given social context. A key point of the explanation is that a value is not established as current by ethical reasoning, but rather by coming to play certain roles in actual social behavior. Value replacement is a matter of certain values supplanting others in their social roles.

The other task of this chapter is to distinguish various roles that social values might occupy, and to describe what is involved in occupying those roles. Of primary

concern are (1) *approbatory* values that serve to sanction certain behaviors as socially acceptable, (2) *commendatory* values that encourage certain social behaviors, and (3) *normative* values that mark certain behaviors as right or wrong. An example of (1) is gratification. A society with this value in place will consider behavior aimed at gratification to be generally acceptable. Examples of (2) and (3) are convenience and tolerance, respectively. Contemporary society encourages convenience in our choice of transportation. And it rules out intolerance as wrong, and hence unacceptable. Of particular note is the status of wealth as an approbatory value. As matters stand, pursuing wealth is socially acceptable, whereas under other circumstances it might be regarded as a social transgression.

Chapter 16 attempts to identify other values current in industrial society that have contributed significantly to our environmental crisis. One such is the approbatory value of gratification mentioned above, which enables consumers to gorge themselves on tasty hamburgers without qualms of conscience. Among the adverse effects of this value is the fact that as much as a million acres of rain forest has been destroyed to produce the meat consumed in fast-food restaurants. Another adverse value is our approval of comfort, which has led to acceptance of air-conditioning as a “basic necessity.” The use of ozone-depleting coolants in air-conditioning equipment has caused extensive damage to both terrestrial and aquatic food-chains. Still another is the value of convenience, mentioned previously, which stands behind society’s preference for private transportation. All said and done, the private automobile is probably responsible for more ecological damage than any other institution of contemporary society.

Chapter 17 responds with a survey of social values that show promise of promoting ecological health. The list of values under this heading is provisional in that the values in question have little force in contemporary society. Although their probable

effects on the environment remain conjectural, however, there is ample reason to expect that these effects would be largely beneficial.

Given the urgent need to *restrain* our profligate use of environmental resources, most of these values will be either commendatory or normative (rather than approbatory). An example is the value of simplicity, which would encourage people to walk when possible rather than driving an automobile. Another is that of moderation, which would encourage people to look beyond taste in their choice of diet. As far as consumerism is concerned, a key example is the value of contentment. People content with what they have will not be moved by the prospect of acquisition, and thus will tend not to respond to techniques of preference management.

It should be clear by this stage of the study that our environmental crisis will not abate as long as social values like those of Chapter 16 remain in place. Although the list of salutary values in Chapter 17 is tentative, it should also be clear that if alternative values of this sort were in place instead the biosphere would benefit appreciably. The final chapter of the study addresses the very substantial question of how value change of this sort might be brought about. What might be done of a practical nature to change the values that shape society's interaction with the rest of nature?

Chapter 18 puts forward suggestions under three general headings. First is the moral equivalent of fighting fire with fire. As things work presently, marketing is used to manipulate consumer preferences in ways that increase corporate profit. If appropriately funded, marketing could also be used to inculcate values of an environmentally-friendly sort. Instead of selling beer and cigarettes, that is to say, ads could be tailored to make people prefer walking over driving large vehicles.

Second is the heading of cooperative action with like-minded individuals. One possibility is to form alliances withholding patronage from organizations whose operations are ecologically damaging, while supporting those that conduct business on an

environmentally sound basis. The more people interact in such activities, the more prominent the values motivating them within society at large.

Third is the heading of individual action. Once people become aware of the environmental consequences of their personal activities (become aware of their “environmental footprint,” so to speak), they will think of (a) things they do presently that should no longer be done (e.g., paying attention to manipulative advertising), (b) things currently done that should be done differently (e.g., cooling homes by natural ventilation rather than air-conditioning), and (c) things not currently done that one should begin doing (e.g., restricting one’s food purchases to local produce). Personal values reinforced by such activities have a way of spreading to friends and neighbors.

Having progressed this far in the summary, some readers may be convinced that the crisis is urgent and want to go directly to Chapter 18 for thoughts on what to do about it. If so, well and good. Nonetheless, the conclusion that the survival of human society as we know it depends upon renouncing the values of consumerism is sufficiently counter-intuitive to require sustained argument for its justification. For readers not convinced antecedently, it is best to pick up the argument from its beginning.

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1. I am indebted to my brother John E. Sayre, author of several distinguished texts in economics, for help in dealing with some of the intricacies of this discipline. He is not to be held responsible for the conclusions of this study, with more than a few of which he disagrees.
  2. A free-market economy is one in which prices are controlled by supply and demand, in contrast with managed economies where prices are controlled by administrative authority. Since most actual economies today have elements of both, they are more accurately described as mixed. The term ‘mixed economy’ has come into standard use accordingly. When the term ‘free-market economy’ is used in this study, it should be

understood as referring to the free-market component of economic systems that may be partially managed as well (e.g., those of Canada and the U.S. as well as Russia).