Environmental Decline and Public Policy

Pattern, Trend and Prospect

Timothy C. Weiskel
and
Richard A. Gray

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Chapter V

Time's Arrow and the Human Prospect

History does not repeat itself,
but sometimes
it rhymes.
[Remark attributed to Mark Twain]

Just as the meaning we ascribe to a word is determined by the context in which it is uttered, so too the importance we assign to events is determined by the context in which we perceive them. Disputes over the interpretation of pattern and trend in history arise not only because people look at different sets of facts but more fundamentally because different people consider the same facts in widely contrasting contexts.

The subconscious narrative which each of us employs to endow events with meaning can at times clash markedly with other narratives that govern the subliminal trajectory of time's arrow in the minds of others. This is often why those who formulate public policy admit to being confused and fail to act decisively on the problems that face them. They are assailed with conflicting versions of what is happening and immobilized by competing visions of what steps to take next.

What, then, is the appropriate context in which to view our contemporary ecological predicament? From what vantage point can we hope to discern pattern, identify trend, and seek to formulate effective public policy? What is the shape of time's arrow for the human prospect?

There is no one answer to this question, even for a single individual. We all live simultaneously in several different contexts, and each provides its measure of meaning for our lives.

Nevertheless, not all narratives are a matter of individual taste, reflecting simply the scenarios we may personally prefer to perceive. Objective measures of human performance are discernible, and objective conditions generated by specific public policy choices will turn out to shape our lives whether or not we perceive them or wish to include them in the stories we tell about ourselves.

Scientific research has helped to clarify a variety of objective narratives of human activity that enable us to see the human story in a new context. In the nineteenth century it became customary to separate "natural history" from "human history," but we are now beginning to realize that this separation of disciplines involved a falsification of both.

The two approaches to history are now being reunited in a new and different kind of narrative about the human prospect.[1]

From the study of ecosystems science, we are learning that as individuals, groups, and as a species we have been imbedded in objective narratives or scenarios of natural process, whether we like it or not—or even, whether we know it or not. It is to these objective scenarios of natural process that those who formulate public policy should now direct their most serious attention.

What we are discovering from the natural science approach to human history is that as a species humankind acts—often unknowingly—as a powerful transforming agent in a complex ecosystem. We have been intruding upon natural ecosystemic process, unleashing cycles and generating scenarios of ecological change over the entire course of human history. Moreover, this intrusion has accelerated enormously since the advent of industrial civilization, just when many people have come to think humankind was "freed" from the constraints of nature.

The ecological "foot print" of industrial civilization is something which we have only begun to document in depth, and we only dimly perceive some of its most obvious dimensions. But, although much remains to be learned, this much we do know and can affirm. Our intrusion into the natural bio-geo-chemical processes has been so massive and our transformation of ecosystemic parameters so thorough that responsible public policy in all realms must now direct itself toward moderating the human impact on its environment or we will face ecosystemic collapse and massive human catastrophe on a vastly greater scale than has ever been recorded in human history.

The contemporary problem of biotic extinction makes this dramatically apparent. Geologists, paleontologists, and evolutionary biologists are now reporting evidence in their professional journals that we are currently in the midst of a global "extinction event" which equals or exceeds in scale those catastrophic episodes in the geological record that marked the extinction of the dinosaurs and numerous other species. Biologists reassure us that the invertebrates and microbial species are likely to survive our current epoch relatively unscathed. Yet, for mammals like ourselves, this message provides small comfort when one begins to realize that the larger point is that *life as we know it* is undergoing massive extinction.[2]

At least two important differences exist between this extinction episode and those previously documented in the geological record. First, in previous events of similar magnitude the question of agency and the sequence of species extinctions have remained largely a mystery. In the current extinction event, however, we now know with a high degree of certainty what the effective agent of systemwide collapse is, and we have

a fairly good notion of the specific dynamics and sequence of species extinctions.

Secondly, previous events of this nature seem to have involved extraterrestrial phenomena, like episodic meteor collisions. Alternatively, the long-term fluctuation of incoming solar radiation that results from the harmonic convergence of the earth's asymmetrical path around the sun and the "wobble" on its axis also drives systemwide changes generating periodic advances and retreats of continental ice sheets in high latitudes. These too cause systemwide transformations and have precipitated extinction events in the past.

In contrast to the celestial phenomena that served as the forcing functions behind previous mass extinctions, the current extinction event results from an internally generated dynamic. The relatively stable exchanges between varied biological communities have shifted in a short period of time into an unstable phase of runaway, exponential growth for a small sub-set of the species mix—namely, human beings, their biological symbionts, and their associates.

The seemingly unrestrained growth of these populations has unleashed a pattern of accentuated parasitism and predation of these growing populations upon a selected number of proximate species that were deemed by them to be useful. This accentuated parasitism led to the creation of anthropogenic biological environments which, in turn, drove hundreds of other species directly into extinction—sometimes within periods of only a few centuries or decades. More significantly, however, this pattern of unrestrained growth and subsequent collapse has repeated itself again and again, engendering in each instance a syndrome of generalized habitat destruction and over time precipitating the cumulative extinction of thousands of species.

For a variety of reasons humans remain fundamentally ignorant of or collectively indifferent to the fate of other species, insisting instead that measurements of human welfare should be the only criteria for governing human behavior. Yet it is upon the enduring presence of other life-forms and the integrity of systemwide functions they perform that human survival depends. Because of this ignorance and indifference anthropogenic biological systems periodically thrust themselves into episodes of radical instability driven by the agency of the dominant species engaged in paroxysms of self-aggrandizing self-destruction.

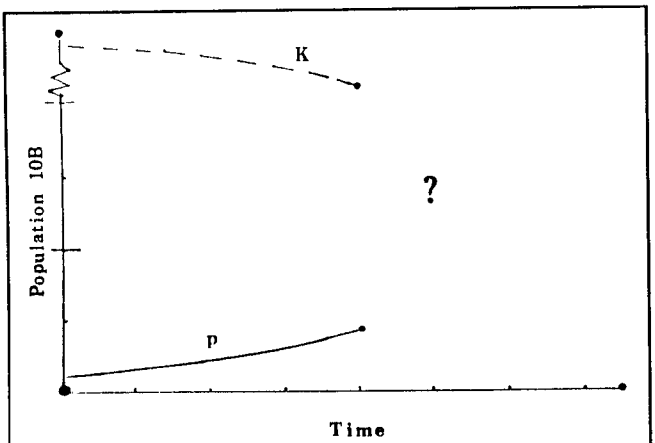
Thus, we live in the midst of an unresolved but rapidly escalating ecological paradox. In evolutionary and historical terms we are too successful for our own good. We refashion the natural world to suit our perceived needs and wants, yet—to date—these anthropogenic microcosms have proved to be ecologically unsustainable and in the long run collectively suicidal for human welfare.

At times it seems as if industrial culture feels itself to be at war with the natural world. The good news *and* the bad news is that we are winning. The human tragedy is that by winning such a war, we defeat ourselves. Those who persist in characterizing the problem as one of human life, human jobs, or human comforts *versus* the environment have misunderstood some basic facts about biological process. The continuity of human life itself requires the preservation of countless other life-forms that we are only now beginning to discover, catalogue, and understand. Those who formulate public policy would do well to remember that if humans pit themselves *against* natural processes, in the long run we cannot help but lose. In short, without some strong and governing principle of limit built into public policy, humans are bound to accelerate their own demise as a species. What is true for all other life-forms in the ecosystem will ultimately prove true for our own species: unfettered growth and unrestrained expansion in a finite system is a formula for extinction.

From an ecosystem perspective the problem can be stated quite starkly. Given its pervasiveness, its pugnacious propensity to alter its environments, and its increasingly powerful technologies, the human species can reasonably be characterized as the latest large scale "natural disaster" which the other life communities on earth have had to endure. In this sense, the evolutionary uniqueness of humans as a species resides not so much in its cognitive capacities or its predilection for symbolic manipulation or its much flaunted intelligence but rather in the fact that it is the first species in evolutionary history capable of inventing and engineering the means of its own extinction.

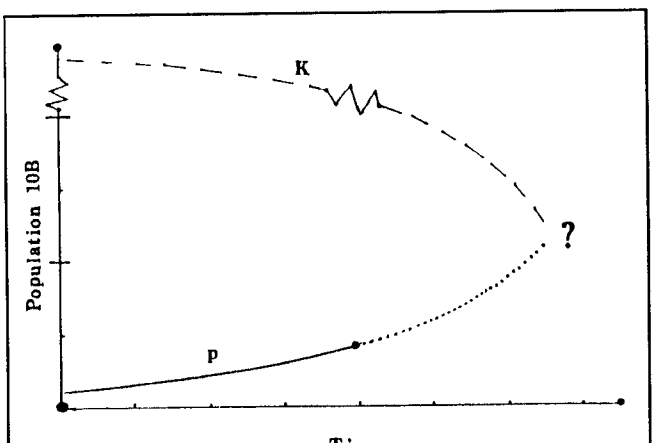
In assessing our contemporary circumstance, then, it is essential for policy makers to keep the long-term historical and archaeological record in mind, for public policy necessarily deals with large-scale and potentially long-term problems. While numeric precision in forecasting may not be possible, several clear patterns emerge from this long-range perspective. In the first place, while we do not know how far current populations are from reaching the earth's carrying capacity, it seems clear that two trends are unfolding: 1) the carrying capacity of at least some local environments is declining measurably; and 2) the population (and hence resource-use) load is simultaneously increasing. (See graphic presentation in figure 1.)

Beyond this, it is not clear what will happen if both of these trends continue on their current trajectory (see figure 2). Nor is it clear what time frame is remaining in which we must as a society and a world community find solutions to these problems.



Declining carrying capacity (K) and increasing population (p). We do not know how wide the separation between the two is, but we do know that one is increasing and the other declining, at least in localized regions.

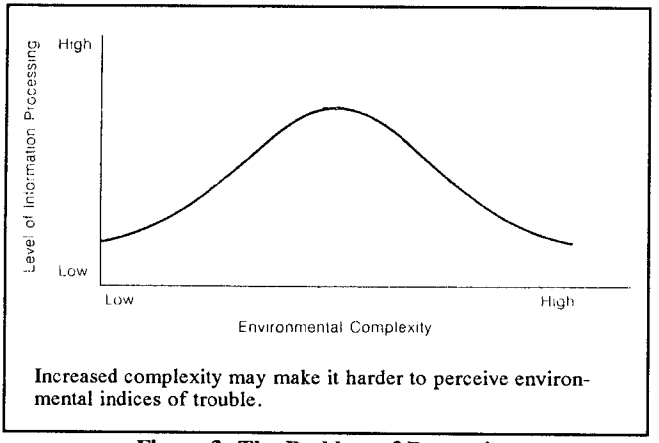
Figure 1: Current Circumstances



What will occur as population (p) approaches carrying capacity (K) is not clear. Nor is the time frame for action yet apparent.

Figure 2: Continuation of Current Trends

Two general phenomena complicate the issue of achieving an adjustment between expanding populations and declining resources. First is the problem of perception. In general, it is recognized that there are upper limits involved in the amount of information that an individual or a society can successfully absorb and act upon. After a certain threshold as the environment becomes more complex, a society's ability to recognize or use information about its own circumstance effectively declines (see figure 3).[3] It is as though things become too complicated to know what is happening.



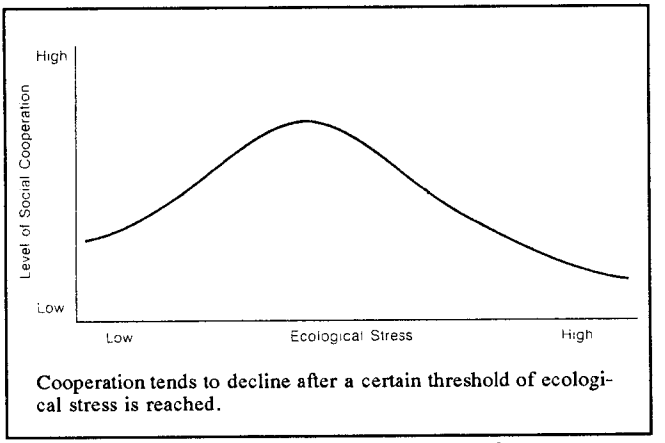
Increased complexity may make it harder to perceive environmental indices of trouble.

Figure 3: The Problem of Perception

This sad circumstance may already reflect our current position with reference to the Third World. Delegates from southern nations at the 1992 Rio summit reached this conclusion after witnessing the apparent lack of urgency on the part of the richer northern nations to reverse the patterns of environmental deterioration in the Third World. In reality ecological problems are now global in scope, and we will need to develop a matching degree of perception. Tropical deforestation affects both local weather and worldwide climate patterns. Food from Iowa feeds both Boston and Burundi. Currently, it is in the Third World that global ecological crises become most pronounced, but it would be a major mistake of perception for Western leaders to assume that the problems in the Third World are merely the Third World's problem.

A second threshold problem seems to be reflected in the general pattern of cooperation observable in societies faced with ecological stress (see figure 4). Initially, as ecological stress mounts, so does cooperation. Society members express a common determination to overcome

difficulty. After a certain threshold of stress, however, this cooperation degenerates, and open conflict can result, leading to political fragmentation. Current famines in Africa are often said to result as much from patterns of ethnic or civil strife as they do from natural phenomena of deficient rainfall or locust plagues. Moreover, as the current disaster in Somalia demonstrates, the shortage of food itself becomes a powerful motivation for warfare. This self-reinforcing syndrome of ecological and social decline is violent and devastating to both human populations and natural ecosystems on an ever-expanding scale in Africa.



Cooperation tends to decline after a certain threshold of ecological stress is reached.

Figure 4: The Problem of Cooperation

Africa is not the only locus of these kinds of eco-social syndromes of fragmentation and collapse. The deterioration of ecological conditions in the former Soviet Union and throughout eastern Europe initially inspired the cooperative effort of many groups to overthrow the outmoded political structures. Nevertheless, as the resulting fragmented communities become anxious about the ecological hazards or waste generated by their neighbors, their willingness to cooperate has declined and their readiness to blame each other has increased.

One troubling aspect of these threshold phenomena is that it is often not clear where the upper levels of tolerance or the breaking points of irreversible deterioration are situated. It would seem that there is a considerable amount of inter-cultural and inter-societal variation in these matters. In addition, unpredictable disasters like the Chernobyl nuclear accident appear to alter both the level of what populations perceive as

stressful in their environment as well as how willing they are to cooperate.

The vision of public leaders can no doubt play a key role in determining the thresholds of perception and cooperation in any given society.[4] For this reason it is vitally important for public policy makers to develop a clear understanding of the nature and scope of global problems even if they address themselves primarily to national, state, or local issues. As stresses increase in the global realm, only the broadest vision of public responsibility is likely to avert the self-consuming syndromes of eco-social decline that have characterized both past civilizations and contemporary circumstances in the Third World.

Broadly speaking, two alternate patterns emerge from the evolving interaction between a growing population and a declining carrying capacity. First, it is possible that a stable adjustment can be achieved (see figure 5). This would be possible if the entire population concerned perceives the problem of adjustment as a real one, and simultaneously cooperates to achieve stabilization. Such a resolution implies that the society can exercise a remarkable degree of self-imposed restraint.

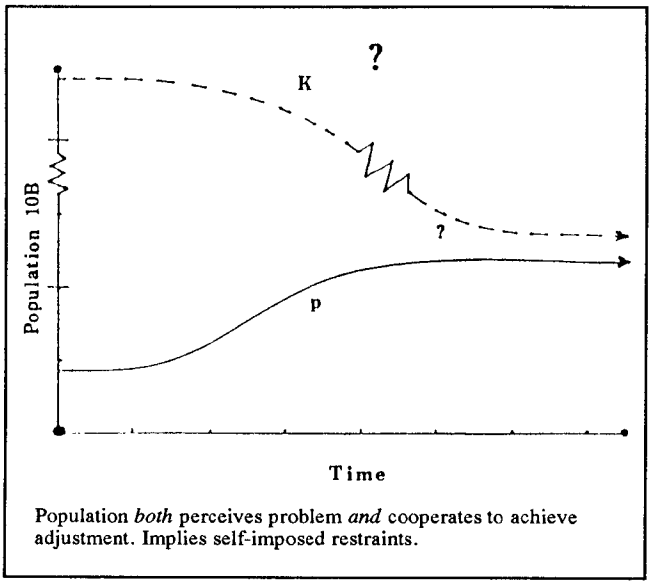


Figure 5: Possible Resolution #1: Stable Adjustment

An alternative resolution of current and future trends involves the phenomena of ecological "overshoot" and subsequent collapse (see figure 6). This would most likely occur either if the society did not perceive the

problem at hand or if it did not succeed in achieving cooperation in a transition to a stable adjustment. The time lag involved between the overshoot and subsequent collapse is not at all clear. Nor is it clear just where we are located at the current moment in either of these two possible scenarios. Some scientists believe that we may already have exceeded the earth's capacity to sustain present populations on a permanent basis.[5] We are perhaps just beginning to witness the phenomena of collapse in indicative catastrophes ranging from repeated Bangladesh floods to chronic African famine.

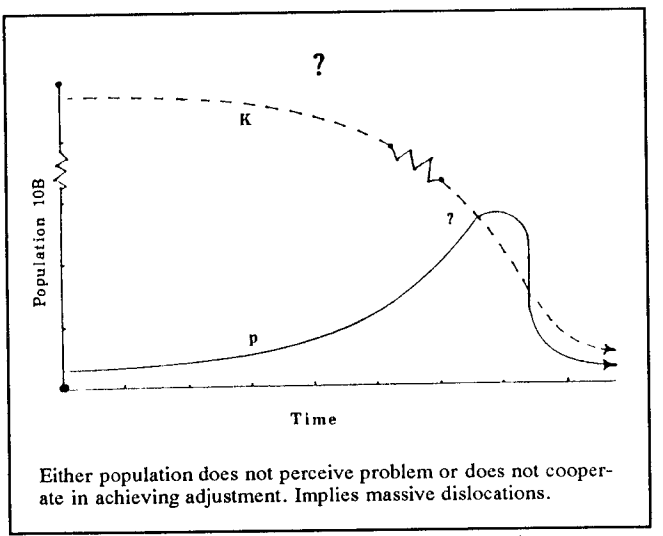


Figure 6: Possible Resolution #2: Ecological "Overshoot" and Collapse

In considering our predicament in reference to these global trends three interlinked patterns in human affairs are troubling to historians of long-term process. First is the somewhat fitful but accelerating pattern of human population growth. Second is the concomitant pattern of global urbanization. Third is the increasing hyper-coherence of the world's food system, its increasing dependence upon fossil energy, and its potential vulnerability to perturbation.

We are so accustomed to notions of an expanding economy with annual interest rates that vary between 3% and 5% that it is difficult for us to understand that in ecosystems this kind of expansion for any given population is unstable, unsustainable, and most often tragic. It is even quite rare in the full course of human history. The industrial era in world

history marks an unprecedented period in human evolution from this perspective. Never before have global human populations experienced such high rates of growth for such sustained duration, reaching a worldwide climax with an average annual population increase of 2% during the decade from 1965 to 1975. The demographic historian, Paul Demeny, has described this extraordinary period quite succinctly:[6]

> It took countless millennia to reach a global 1700 population of somewhat under 700 million. The next 150 years, a tiny fraction of humankind's total history, roughly matched this performance. By 1950 global human numbers doubled again to surpass 2.5 billion. The average annual rate of population growth was 0.34% in the eighteenth century; it climbed to 0.54% in the nineteenth century, and to 0.84% in the first half of the twentieth. In absolute terms, the first five decades following 1700 added 90 million to global numbers. Between 1900 and 1950, not withstanding two world wars, and influenza pandemic, and a protracted global economic crisis, the net addition to population size amounted to nearly ten times that much.

As Dr. Demeny summarized the situation:

> Clearly, viewed in an evolutionary perspective, the 250 years between 1700 and 1950 have witnessed extraordinary success of the human species in terms of expanding numbers, *a success that invokes the image of swarming.*[emphasis added]

For demographic historians, then, it would seem that humans in the modern era are behaving much like a plague of locusts.

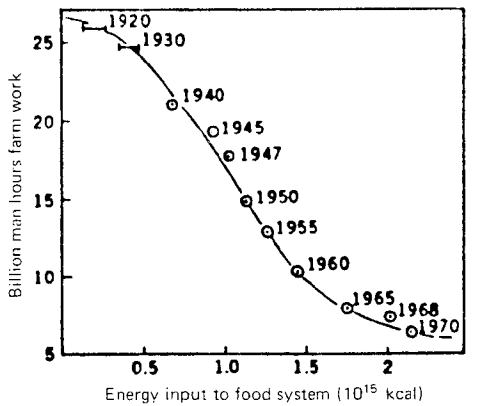
What is even more striking is that the pattern of distribution of this burgeoning population is one of rapid relocation into massive urban agglomerations. In 1700 less than 10% of the total world population of 700 million lived in cities. By 1950 a full 30% of the global population lived in cities. In North America the urban proportion of the population had reached 64% by that time while in Europe it was 56%.

In 1700 only 5 cities in the world had populations of 500,000 people. By the turn of this century that number had risen to 43 cities in the world with populations of 500,000 or more. Of those, only 16 cities had populations over 1,000,000. By now, however—that is to say in a span of under 100 years—there are nearly 400 cities that exceed 1,000,000, and there will soon be scores of cities with populations in excess of 10,000,000 people, particularly in the Pacific rim countries. Once again

the insect image seems appropriate. It is as if collectively we are swarming, moving, and landing in concentrated hives of human activity.[7]

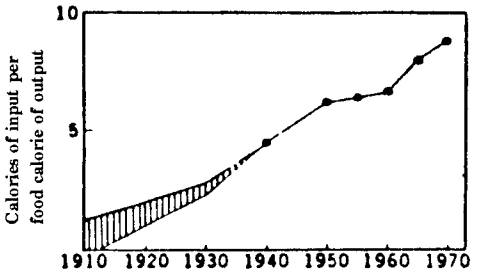
These two major patterns of recent human history are striking enough to raise the question as to whether either one or both can be sustained. So far these remarkable phenomena have been made possible only because of a matching increase in the output of agricultural production. Yet it is precisely with reference to the changing structure of the world food system that the third and perhaps most worrisome trend appears to be developing on a global scale.

Briefly put, industrial agriculture, and American agriculture in particular, has achieved enormous levels of output through a pattern of substituting human agricultural labor with fossil fuel-driven machines and chemicals. This is not an especially new or original insight. As long as twenty years ago, concerned analysts of American agriculture warned that, while there has been a substantial decrease in the human labor used on American farms during this century, there has been an overall *increase* in the energy subsidy required to obtain one calorie of consumable food in the American food system (see figures 7 and 8).[8]



Labor use on farms as a function of energy use in the food system. The relative amount of labor input to American agriculture has declined remarkably.

Figure 7: Declining Labor Input

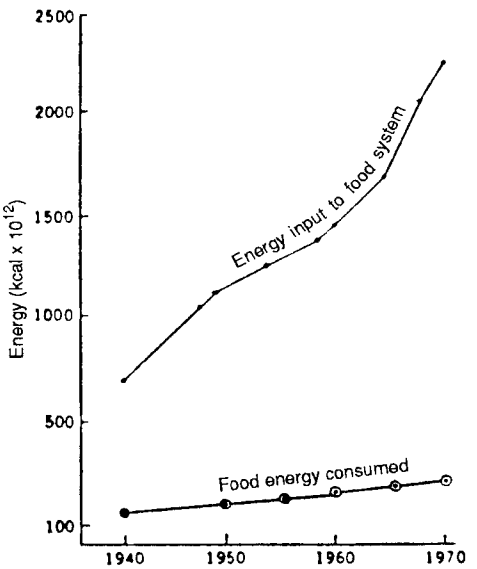


The total energy subsidy needed in the entire food system to produce one calorie of food has increased substantially. Thus, while labor efficient, the American food system is energy inefficient. This will need to change in a post-fossil fuel age.

Figure 8: Increasing Energy Subsidy

Moreover, the vast majority of the energy subsidy provided to the food system in the United States is not reflected in the amount of food energy actually consumed (see figure 9). That is to say, more and more of the energy absorbed in the food production system as a whole is going into the necessary but ancillary aspects of agricultural production—the transport systems, the food processing systems, the cold storage systems, and so on.

Finally, the long-range trend from the 1920s until the present suggests that increases in energy inputs into the system have been approaching a point of diminishing returns in terms of overall food production. In other words, if this trend persists, future increases in food output will require even higher rates of energy inputs (see figure 10) for correspondingly diminished returns. This is a disturbing circumstance, particularly in view of the total collapse of food self-sufficiency of large numbers of Third World countries.

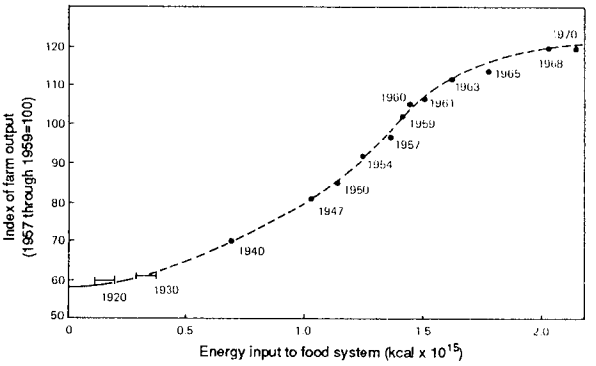


Energy use in the food system, 1940 through 1970, compared to the caloric content of food consumed. Most of the energy absorbed in the food system has not been reflected in a corresponding output of food.

Figure 9: Comparison of Energy Input and Food Energy Consumed

In an aggregate sense, of course, it may well be true that there is more food per capita in the present world than ever in history. This does not alter the fact that more people are dying of starvation now than at any point in human history. It could be argued that this is just a "distribution problem," having to do with politics more than agriculture or long-term ecological viability of the global food system, but such an argument misses the main point about the inter-connected nature of social and ecological issues.

The fact that these structural vulnerabilities in the world food system have been well known by experts and warned about for decades is not encouraging, for virtually nothing has been done by way of crafting public policy to reverse these circumstances in the intervening years. On the contrary, since the 1950s more and more people have come to



Farm output as a function of energy input to the U.S. food system, 1920 through 1970. Over time, there appears to be a pattern of diminishing returns in the relation of the amount of energy put into the food system and the amount of output obtained from it. The pattern suggests that future increases in output are likely to be energy-expensive, and financially even more so, as the price of oil increases.

Figure 10: The Problem of Diminishing Returns

depend upon fewer and fewer crop species grown more and more intensively on depleted soils and diminished land surfaces in regions that are farther and farther away from the points of consumption. The entire food system requires an already enormous and steadily increasing subsidy of fossil fuels to maintain itself. It will require even more to expand in relation to growing human populations.

These trends cannot persist for very long into the future without exhibiting increased vulnerability to variable weather patterns, oil price stability, pest and predator outbreaks, and various forms of economic and political instability. The current famine and total collapse of civil order in Somalia demonstrates with brutal ferocity the consequences for millions of people when a region becomes exclusively dependent upon external sources for food. Yet the same syndromes of underdevelopment and growing food dependency manifest so dramatically in that case are now in various stages of evolution in scores of Third World countries.

In order to survive in the coming decades those who formulate public policy will need to transform global agro-ecosystems away from petro-based toward bio-sustainable forms of agricultural technology. We cannot predicate our agriculture on fossil fuels and expect that agriculture to outlast the supply of this resource.

Unless public policy decisions are made in the near future to reverse the rapid increase in global dependence upon petroleum-based agriculture, we can expect wide-scale dislocations including famine, ensuing disease and open armed conflict to emerge on an expanding scale as supplies of that non-renewable resource decline and competition to control its use intensifies. We live in a highly industrialized, urban society, but it is important to remember that although we think we possess a "post-industrial" culture, there is no such thing as a "post-agricultural" society. Policy decisions concerning agriculture, our environment and the future construction of our economic infrastructure —water projects, transport systems, land-use patterns, and so on—all need to reflect this fundamental truth. Cultures that failed to understand this in the past have proved to be short-lived. We will be no exception to this repeated pattern in human history.

In effect, these three global trends of population growth, urbanization, and petro-intensification in agriculture form a powerful interacting syndrome of self-reinforcing and accelerated environmental decline. Each component in the syndrome works to aggravate the others. Population growth, particularly in impoverished rural regions, forces people off the land and into the cities. Growing urban populations are politically unstable unless cheap food supplies can be assured. The demand for cheap food in cities drives the expansion of the global trend toward petro-intensification in agricultural production as well as the concomitant growth of long-distance trade in foodstuffs.

The petro-intensification of agriculture works to benefit agricultural firms with sufficient capital to purchase the mechanical and chemical inputs, but it frequently reduces income and welfare of competing peasant households.[9] The response of the peasant household is to increase its output by increasing its labor input—that is, by having more children to provide the vital manpower. Thus, it is in the poorest of rural regions that one often finds the largest surge of population growth.

The lands in rural regions become increasingly impoverished for two broad reasons. Either the expanding petro-intensive technologies work to change the soil structure, accelerate soil erosion, contaminate ground or surface water supplies, and so on.[10] Or peasant agriculturalists, in the face of declining real prices for foodstuffs and cash crops, resort to over-cropping and over-grazing already marginal lands and frequently fight to retain or restore land rights to more fertile areas.[11]

The net effect on the overall interacting system is similar. Peasants are either displaced from their lands by the growing mechanization of agriculture or they migrate off the remaining marginal lands as their declining fertility no longer affords a sufficient return for their expanded families. In either case these landless peasants find their way to the cities, reinforcing the global pattern of urbanization and subsequent

demand for continuous cheap food. The vicious circle or syndrome of accelerating environmental decline is complete.

It is important to recognize that there is no self-limiting or self-corrective counter tendency in the interaction of these three major components that can assure sustainability. In ecosystemic terms, there is no natural negative feedback loop to assure systemwide stability. On the contrary, these three global trends form interlocked components in a massive and powerful positive feedback loop driving a global syndrome of runaway environmental decline.

Only the careful elaboration of deliberate public policy can hope to slow and eventually reverse this global syndrome of decline and lead to stable ecosystemic adjustment. Those who argue, on the contrary, for the reduction of governmental attention to these matters—suggesting instead that some "invisible hand" will bring about the requisite adjustments—are abandoning global urban civilization to suffer the historical fate of all positive feedback syndromes: inevitable overshoot and collapse.

While the archaeological and historical record is filled with tragic reoccurrences of this syndrome, previous tragedies have been largely local or regional phenomena. Now, however, we face the prospect of wide-scale and potentially global disruptions. Markets in oil and food are global. Increasing urbanization is universal and aggregate population growth is occurring at a rate of nearly 1.8% per annum. Disruptions in any one of these interacting trends will intrude upon each of the others on a scale never before witnessed in human history.

To reduce the scale of such tragedy, those who make public policy must come to realize that it is unwise to shape our environment and continue to construct the urban and agricultural infrastructure in a manner that commits global agricultural production irretrievably to a non-renewable resource in a time of continuous population expansion. Such a strategy may well succeed in generating decade-long or even generation-long spurts of production to provision the cash wealthy and politically influential populations in expanding urban centers. Nevertheless, in the long run this course of action will prove to be a public policy blunder. In ecological terms, the short term success would be a recipe for long-term disaster. The world cannot continue to support current rates and patterns of global urbanization, and the cities themselves cannot sustain the growing disparity of income and welfare between the wealthy few and the impoverished masses, particularly in the Third World.

The time remaining to engineer a global transition toward a post-petroleum agriculture, sustainable urban forms, and a stabilized population is not long when measured in the span of decades and centuries that are normally necessary for successful social adaptation to technological innovation. If Somalia-like catastrophes are to be averted throughout the Third World and elsewhere in the years and decades ahead, those

responsible for formulating public policy must begin now to arrest and reverse the syndromes of environmental decline that have led in the past and will lead in the future to the tragic pattern of overshoot and collapse in urban civilizations.

There are encouraging signs that at least some political leaders are beginning to see the scope of the problem at hand. Moreover, concerted research is now underway to analyze the favorable combination of changed circumstances and personal leadership abilities that enable courageous public figures to forge new and imaginative public policy when it is most needed. The results of this research on innovative policy formulation are likely to go a long way to help us understand the kind of leadership our global urban civilization will need to survive in the twenty-first century.[12]

For its part, however, the public must now learn both to demand and to reward public figures who are courageous enough to demonstrate environmental leadership on a global scale. It will no longer be sufficient to elect to local or national office those figures who simply succeed in putting together temporary coalitions of 50 percent plus one of the active electorate. A larger vision of community is essential.

Just as more imaginative leadership is called for, so to a larger understanding of citizenry will be required to reverse both local and global patterns of environmental decline. And this, in turn, will require a massive public education effort conducted through both the mechanisms of formal education and the broader public media. As catastrophic events like earthquakes and hurricanes demonstrate, public-minded citizens respond spontaneously and generously when they are informed of disasters in such a way that they feel themselves to be connected to the victims of tragedy. In reality, we are all connected to the victims of accelerated environmental decline throughout the world, and we must develop the means of communicating this in such a way as to engender and inspire a growing sense of global citizenry in the complex and interdependent ecosystem we have come to inhabit.

During 1992, the Carnegie Endowment for International Peace in Washington convened a *National Commission on America and the New World* to examine the crisis of leadership provoked by the decline of Soviet power and the shift of international focus in the post-Cold War world toward problems of environmental change and sustainable development. This blue ribbon commission included distinguished elected officials, civic leaders, academic experts, and business people, and in August 1992 it published a summary report of its findings and recommendations. As part of its assessment of the American's new international responsibilities the report draws to a close with this sober observation:[13]

> We conclude where we began—foreign policy begins at home. We must make real for our own people the values we champion on the international scene even as we must manage our national resources in responsible fashion.
>
> Changing our domestic ways also compels reexamination of our structures of government and our education for international affairs. For we are a country ill-equipped for new priorities. Our institutions creak with anachronisms. Many leaders proclaim change but act as if nothing has changed. And we are not preparing the next generation of Americans to understand, much less lead, in a transformed world.

The commission goes on to emphasize that: "It will be the character and quality of people, not the adequacy of machinery, that will determine success."[14] The report ends by underscoring the fact that far more than the change of particular policies is at stake:[15]

> ...this Commission has concluded that simply altering our policies will not suffice.
>
> "The release of atom power," Albert Einstein once noted, "changed everything except our way of thinking."
>
> What troubled Einstein troubles us. We have to change our "way of thinking."

The Carnegie Commission has articulated in new and compelling terms what ecosystem scientists have been urging us to consider for years. Our leadership as well as the public at large must come to understand that our way of thinking requires substantial change. The clarity of our thought about global ecological circumstance—the larger context within which we consider all human activity—will determine whether or not we will be able to devise effective public policy for secure survival. Only if we succeed in generating a new kind of leadership supported by an informed and motivated citizenry will the shape of time's arrow promise significant hope for the human prospect in the twenty-first century.

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NOTES

1. The effort to re-unite natural history and human history is apparent in several recent attempts by scientists to write narratives that highlight the impact of natural process on human societies. Climate history has provided the archetype of this approach. See, for example, Reid Bryson and Thomas J. Murray, *Climates of Hunger: Mankind and the World's Changing Weather* (Madison: Univ. of Wisconsin Press, 1977); H.H. Lamb, *Climate History and the Modern World*, (London: Methuen, 1982); the collection of papers edited by Richard L. Wyman, *Global Climate Change and Life on Earth* (London: Routledge, 1991); and Stephen H. Schneider and Randi Londer, *The Co-Evolution of Climate and Life* (San Francisco: Sierra Club Books, 1984).

In addition, scientists have examined biological and human agency as an aspect of natural history. Geography, historical geology, environmental archaeology, and historical epidemiology as well as the history of plant and animal invasions or migrations have provided much of the case material for these kinds of narratives. See: Peter Westbroek, *Life as a Geological Force: Dynamics of the Earth* (New York: W. W. Norton, 1991); Neil Roberts, *The Holocene: An Environmental History* (Oxford: Basil Blackwell, 1989); I.G. Simmons, *Changing the Face of the Earth: Culture, Environment, History* (Oxford: Basil Blackwell, 1989); R.H. Groves and J.J. Burdon, eds., *Ecology of Biological Invasions* (Cambridge: Cambridge University Press, 1986); and Ann F. Ramenofsky, *Vectors of Death: The Archaeology of European Contact* (Albuquerque: Univ. of New Mexico Press, 1987).

Moreover, traditional historians of human endeavor have sought to reexamine the natural setting and the ecological transformations engendered by deliberate or inadvertent human activity. Studies have emphasized the interaction or co-evolution of human and natural environments. In addition to the works discussed in Chapter II above, see, for example, Redcliffe N. Salaman, *The History and Social Influence of the Potato* [First printed in 1949; revised impression edited by J.G. Hawkes] (Cambridge: Cambridge Univ. Press, 1987); William H. McNeill, *Plagues and Peoples* (New York: Doubleday/Anchor, 1976); Emmanuel Le Roy Ladurie, *Times of Feast, Times of Famine: A History of Climate Since the Year 1000* (Garden City, NY: Doubleday, 1971); and Meredeth Turshen, *The Political Ecology of Disease in Tanzania* (New Brunswick, NJ: Rutgers Univ. Press, 1984).

Finally, we are beginning to see the development of large-scale historical narratives that try to synthesize what is known about human historical ecology. See, for example, Daniel J. Hillel, *Out of the Earth: Civilization and the Life of the Soil* (New York: The Free Press, 1991); Paul Colinvaux, *The Fates of Nations: A Biological Theory of History* (New York: Simon and Schuster, 1980); Stephen Boyden, *Western Civilization in Biological Perspective* (New York: Oxford Univ. Press, 1987); and Clive Ponting, *A Green History of the World: The Environment and the Collapse of Great Civilizations* (New York: St. Martin's Press, 1991).

2. The issue of contemporary extinctions is often discussed under the general category of declining "biological diversity." See: E. O. Wilson, ed., *Biodiversity* (Washington, DC: National Academy Press, 1988); and John Terborgh, *Where Have All the Birds Gone?* (Princeton: Princeton University Press, 1989).

Recent popular accounts of the present extinction spasm include: Niles Eldredge, *The Miner's Canary: Unraveling the Mysteries of Extinction* (New York: Prentice Hall Press,

1991); and R.J. Hoage, *Animal Extinctions: What Everyone Should Know* (Washington, DC: Smithsonian Institution Press, 1985).

A particularly important type of extinction that has concerned scientists in recent decades is the loss of plant genetic diversity in food crop species. See: Cary Fowler and Pat Mooney, *Shattering: Food, Politics, and the Loss of Genetic Diversity* (Tucson: Univ. of Arizona Press, 1990); Robert and Christine Prescott-Allen, *Genes from the Wild: Using Wild Genetic Resources for Food and Raw Materials* (London: International Institute of Environment and Development, 1983); and Vandana Shiva, et al., *Biodiversity: Social and Ecological Perspectives* (Penang, Malaysia: World Rainforest Movement, 1991). The "genetic erosion" of plant cultivars has proceeded along with the simultaneous extension of petro-intensive forms of agriculture in many areas of the Third World. This phenomenon forms one of the themes of the critique concerning the trends in evolution of the global food system. See discussion and sources cited below.

3. The concepts represented in this and the following graphic are adapted from the analysis presented in Charles D. Laughlin, Jr. and Ivan A. Brady, "Introduction: Diaphasis and Change in Human Populations," in *Extinction and Survival in Human Populations*, edited by Charles D. Laughlin, Jr. and Ivan A. Brady (New York: Columbia University Press, 1978).

4. The perception and stress models here are adapted from those presented by Charles D. Laughlin, Jr. and Ivan A. Brady, "Introduction: Diaphasis and Change in Human Populations," in *Extinction and Survival in Human Populations* (New York: Columbia University Press, 1978), pp. 1-48.

5. In this connection see the views of several eminent members of the National Academy of Sciences as reported from a conference of biologists at Stanford: "'Population Bomb' Still Ticking," *UPI News*, 3 Sept. 1988, 11:57 am.

6. Paul Demeny, "Population," in B. L. Turner, et al., eds., *The Earth as Transformed by Human Action: Global and Regional Changes in the Biosphere over the Past 300 Years* (Cambridge: Cambridge University Press, 1990), p. 43.

7. For a detailed discussion of these and other figures on global urbanization trends, see: Brian J. L. Berry, "Urbanization," in B. L. Turner, et al., eds., *The Earth as Transformed...*, p. 103-119.

8. The graphs in figures 7-10 are adapted from: John S. Steinhart and Carol E. Steinhart, "Energy Use in the U.S. Food System," *Science* 184 (19 April 1974), pp. 307.

For an analysis of the trends in energy use in American and global agriculture, see: John Steinhart and Carol E. Steinhart, *Energy: Sources, Use, and Role in Human Affairs* (Duxbury, MA: Wadsworth/Duxbury Press, 1974); David Pimentel and Marcia Pimentel, *Food, Energy and Society* (New York: John Wiley, 1979); Maurice B. Green, *Eating Oil: Energy Use in Food Production* (Boulder, CO: Westview Press, 1978); and John Gever, et al., *Beyond Oil: The Threat to Food and Fuel in the Coming Decades* (Niwot, CO: University Press of Colorado, 1991).

9. See the annotations above on pages 161-182. In addition, for further social and economic critiques of the petro-intensive "green revolution," see: Andrew Pearse, *Seeds of Plenty, Seeds of Want: Social and Economic Implications of the Green Revolution*

(Oxford: Clarendon Press, 1980); and Vandana Shiva, *The Violence of the Green Revolution: Third World Agriculture, Ecology and Politics* (London: Zed Books, 1991).

Because of the mixed outcome and inherent instabilities of the green revolution technologies, the promise of abundance from the "gene revolution" afforded by new types of biotechnology is often regarded with suspicion by analysts of the world food system. See: Henk Hobbelink, *Biotechnology and the Future of World Agriculture* (London: Zed Books, 1991); Lawrence Busch, William B. Lacy, Jeffrey Burkhardt, and Laura R. Lacy, *Plants, Power, and Profit: Social, Economic and Ethical Consequences of New Biotechnologies* (Oxford: Basil Blackwell, 1991); and Jack R. Kloppenburg, Jr., *The First Seed: The Political Economy of Plant Biotechnology, 1492 - 2000* (Cambridge: Cambridge University Press, 1988).

10. The petro-intensive nature of modern agriculture has degraded the environment and human health in many Third World areas. See the works annotated on pages 161-182 above, particularly, David Weir and Mark Schapiro, *Circle of Poison: Pesticides and People in a Hungry World* (San Francisco: Food First, 1981); David Bull, *A Growing Problem: Pesticides and the Third World Poor* (Oxford: Oxfam, 1982); and David Weir, *The Bhopal Syndrome: Pesticide Manufacturing in the Third World* (Penang, Malaysia: IOCU, 1986).

11. See particularly, Tom Barry, *Roots of Rebellion: Land and Hunger in Central America* (Boston: South End Press, 1987); and Robert G. Williams, *Export Agriculture and the Crisis in Central America* (Chapel Hill: Univ. of North Carolina Press, 1986).

12. A multi-year research project led by Professor John Montgomery of the John F. Kennedy School of Government at Harvard University is focusing the necessary characteristics and minimal components of what he calls "mega-policies," or genuinely new innovations in public policy, to face unprecedented circumstances.

13. Carnegie Endowment National Commission on America and the New World, *Changing Our Ways* (Washington, DC, Carnegie Endowment for International Peace, 1992), p. 85.

14. Carnegie Endowment, p. 86.

15. Carnegie Endowment, p. 87.