

ON THE HUMAN CONDITION: COUNTDOWN TO 2015

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ABSTRACT: Many people are appalled by the reports of rampant death by disease and starvation that are coming from less-industrialized countries such as Rwanda or Haiti. Predictions of their occurrence started to appear in the scientific literature in the early 1960's. More recent studies have echoed these conclusions. In this paper, the development of increasingly sophisticated computer simulations of the future of humankind are discussed. The problems that these simulations point out have yet to be dealt with in an effective manner.

KEYWORDS: *Beyond the Limits*, famine, food shortages, *Global 2000*, *Mankind at the Turning Point*, overpopulation, starvation, *The Limits to Growth*.

INTRODUCTION

In 1992, two events occurred whose juxtaposition should have been the cause of great foreboding. US troops entered Somalia to aid in distributing food, and the twentieth anniversary of the publication of *The Limits to Growth*, a book dealing with the computer simulation of the future of humankind, was observed. The one event focused our attention on our fellow humans, while the other caused a brief ripple in the popular press and then faded from view. Why was the anniversary of the publication of *The Limits to Growth* and the release of its companion volume, *Beyond the Limits*, so widely disregarded?

One reason might be the way environmental science and ecology are taught. A large number of environmental science and ecology texts have been published in the last 25 years, but they rarely include a discussion of how the various environmental problems impact each other (e.g., Kupchella and Hyland, 1993; Smith, 1992; Stiling, 1992). Their coverage is limited to a topic by topic recitation of the woes of the world.

Another reason might be our own inability to face the issue squarely. Deciding to stand up for the rights of the spotted owl is quite easy in comparison to simultaneously facing a large number of interconnected problems, particularly if those problems must be related to our personal values, our accustomed lifestyle, societal standards, and the lifestyle we feel all people should have.

In this paper, six landmark publications dealing with possible human futures are reviewed in chronological sequence. As their authors have pointed out, the conclusions discussed here are not predictions. The authors of these books only discuss possible outcomes based on the data available at the time the books were written.

The conclusions expressed in this review are those of the books' original authors, presented as impartially as individuals who are concerned with their own and their children's futures can be. Our own opinions intrude largely in the closing summary. Unfortunately, the conclusions reached in all these texts are terrifyingly consistent. They must be confronted. This review will direct interested readers to

the relevant literature and allow teachers to introduce the fundamentals of ecological computer simulation into their classrooms.

FAMINE 1975!

The interrelationship between food supply and human population has been of continuing interest to ecologists, demographers, and conservationists for the last thirty-five years. Interest in this relationship was kindled by two books, *Hungry Nations* and *Famine 1975!* (Paddock and Paddock, 1964, 1967, 1976), which dealt with food production and re-emphasized the predictions made by Thomas Malthus (in Hardin, 1969, pp. 4-16) in "An Essay on the Principle of Population," which dealt with overpopulation.

The arithmetic increase in food production was juxtaposed with exponential population growth as an augur of starvation by Malthus in 1798 in response to the alarming population boom of the late eighteenth century (in Hardin, 1969, p. 15):

The happiness of a country does not depend, absolutely, upon its poverty or its riches, upon its youth or age, upon its being thinly or fully inhabited, but upon the rapidity with which it is increasing, upon the degree in which the yearly increase in food approaches to the yearly increase of an unrestricted population.

Malthus was largely forgotten, because the Industrial Revolution and the colonization of the Americas relieved population pressures on European food resources.

Malthus' dormant theme was taken up by William and Paul Paddock. These brothers, one an agronomist and the other a US Foreign Service Officer, wrote *Hungry Nations* in 1964 out of their personal experience and exposure to famine in the less-industrialized nations. The Paddocks felt that tangible resources (i.e., air, land, and water) determine a nation's wealth. The resource might be nonrenewable, like oil, or renewable but susceptible to erosion/exhaustion, such as the amount of arable soil. When a nation can produce a surplus of goods in excess of the needs of its populace by developing its tangible resources, it progresses. The root cause of poverty and starvation in the hungry nations is population in excess of resources.

The Paddocks warned against feeding hungry nations. If food is charitably shipped to meet a food emergency, then a larger population will have to be fed when the next "emergency" occurs. Since the American wealth that produces surplus food is not inexhaustible, America will not be able to feed the hungry nations forever. Food recipients must develop the ability to feed themselves.

The Paddocks note that agricultural research is not a luxury a hungry nation can do without. A region's agricultural development and production are shaped by its local environmental conditions. The detailed research that has led to the successful agricultural technologies of temperate North America is of little or no use in a foreign locale. Fortunately, if the hungry nation acquires the ability to feed itself, local agricultural research, although more difficult, more protracted, and more vulnerable to loss of funding than industrial research, will pay for itself.

Despite their initial optimism, the severity of the food-population imbalance escalated more rapidly than the Paddocks expected. In 1967, the Paddocks published *Famine 1975!*. In this work, they stated that inevitable famines were looming on the horizon due to the collision of exponential population growth with

stagnant food production. For the first time, America would have to choose amongst deserving recipients of food rather than just responding with gifts for everyone.

The Paddocks' method for choosing among food recipients was called "triage." Triage identifies three types of hungry nations. The "can't be saved" have populations that have already surpassed their agricultural potential. The "walking wounded" have the resources to produce or buy the needed food and, therefore, can cope with their population growth. The "walking wounded" should be able to correct their own problems. Nations "that should be helped" have a manageable degree of imbalance between food and population. They "should be helped" even though the imbalance is great, and they cannot be immediately expected to correct the imbalance by themselves.

Food aid to the nations "that should be helped" would allow dynamic local leadership sufficient time to initiate effective birth control practices and to proceed with agricultural research and development. America's responsibility would be to administer and enforce policies for self-reliant development in recipient nations. The recipient nation's responsibility would be to "pay for" that aid by participating in birth control programs and heavy agricultural investment.

TRAGEDY OF THE COMMONS

Many people rejected what the Paddocks said because they believed that a technological solution, requiring "...a change only in the techniques of the natural sciences, demanding little or nothing in the way of change in human values or ideas of morality" (Hardin, 1969, p. 367), was possible. Garrett Hardin (in Hardin, 1969, pp. 367-381) in his essay, "Tragedy of the Commons," showed that this belief was not valid. In a commons, it is in every man's best interest to maximize his use of a scarce resource at everyone's expense, including his own, because his loss is a lesser portion than his gain. "...freedom in a commons brings ruin to all" (Hardin, 1969, p. 371) and therein lies the tragedy. (The term "commons" referred initially to the pastureland available to English farmers for raising livestock. In America, the last great commons is our system of National Parks and Forests. Internationally, the last great commons is the sea. The fishing and whaling industries and their declining catch sizes are ample proof of the tragedy of the commons. The unregulated market system (the fishing industry) is rewarding the destruction of the resource held in the commons (the fish) on which it is based.) There is no technological solution to overpopulation. Freedom to breed will bring ruin to all.

THE LIMITS TO GROWTH

The authors of the previous books appealed to their readers' emotions to bring about change. A desire to project their conclusions into the future led to the introduction of the computer into the decision-making process. In 1972, *The Limits to Growth* (Meadows, *et al.*, 1972) was published by the Club of Rome, an informal, international group of businessmen and experts in various scientific fields. Their computer model (World3) was based upon five (actually six, if the service sector is considered) interconnected feedback systems modeling industrial-

ization, population growth, agricultural production, resource consumption, and pollution. All six systems were growing (and continue to grow) exponentially.

Using their computer model, the investigators reached three conclusions. First, a continuation of present trends would result in the world system's overshooting an upper limit (resource availability) sometime within the next century, after which a rapid and uncontrollable collapse (or crash) in industry and then population would occur. Technological advances would not prevent the collapse, because the interlocking feedback loops that make up the world system assure collapse even if only one limit is exceeded. Second, a state of global equilibrium could be achieved by lowering population growth rates, conserving resources, and emphasizing investment in agriculture and the service industries, but not in manufacturing consumer goods. When equilibrium is achieved, every person would have his/her basic needs met and would reach his/her full potential. Finally, the probability of success would decrease with each passing year, because the high rates of change insure that the world system would exceed a natural limit.

The Limits to Growth called for a radical reorganization of human society. Many people chose to reject it (Club of Rome, 1973). Such a highly aggregated (i.e., world) model could not provide a platform for policy change, because the projected trends would not occur with the same severity throughout the world. In addition, technological innovation and industrial growth continued to be touted by traditional economists. The model was too inflexible and could not account for the development of new technologies. (Countering these arguments is the fact that experience has shown that the biosphere is more sensitive to pollution than the model predicted.)

MANKIND AT THE TURNING POINT

These criticisms were addressed rather quickly in a second report, *Mankind at the Turning Point* (Mesarovic and Pestel, 1974). How did the new computer model differ from the one used in *The Limits to Growth*? The number of variables studied increased from a few hundred to over 100,000. The model was also regionalized to account for the political, cultural, and economic diversity of different parts of the world. Each region's development was then simulated at several levels, starting with the individual and ending with the ecosystem. Finally, societal and technological change could be injected into the operation of the model at any time. As a result of these changes, the different regions would face different crises at different times, and there was no dominant, single limit to the world system.

Food remained the most precious of resources. To allow any hope of success, massive investment and a transfer of all applicable technology from the industrialized into the less-industrialized countries would have to occur very early to close the food-supply gap and the import-export imbalance in the less-industrialized world. Regional populations would have to be stabilized. Due to the high rate of change, delay would reduce our options. A global approach would be necessary because all parts of the world system are ultimately interdependent.

The conclusions reached in *Mankind at the Turning Point* were basically the same as those reached in *The Limits to Growth*. The prescribed remedies, which

require a long-term commitment to change as well as a continuity in global leadership, must be implemented before the crises become apparent.

GLOBAL 2000

In 1977, President Carter focused the attention of the entire Federal Government on these problems for the first time. The Council on Environmental Quality and the Department of State were directed to cooperate with other government agencies to investigate possible changes in the world system through the end of the century. The result was *Global 2000: The Report to the President Entering the 21st Century* (Barney, 1980),

Global 2000 projected that the world's population would increase 55% to 6.35 billion by the year 2000, with 92% of the growth occurring in less-industrialized countries. Food production was projected to increase at a rate of 2.2% per year, paralleling the record increases recorded during the 1950's and 1960's (which included the high-yield grain varieties developed during the Green Revolution). By the year 2000, the number of people supported on 1 hectare of farmland in 1970 would have to increase from 2.6 to 4 people through an increased use of fertilizer, pesticides, herbicides, and irrigation (i.e., energy-intensive, yield-enhancing inputs). Per capita food consumption was projected to increase by 15% over this period. This increased consumption would occur in the already well-fed, industrialized nations. Overall, the number of malnourished people was projected to increase from half a million in 1970 to 1.3 billion in 2000.

When *Global 2000* was revised in 1988, the projected food yields were reduced to reflect diminishing returns from the use of energy-intensive, yield-enhancing inputs and a decline in the carrying capacity of the land. In its revised form, *Global 2000* reached the same conclusions as *Mankind at the Turning Point*; i.e., that a sustainable economy coupled with environmental protection, resource conservation, and limited population growth was imperative. "The needed changes go far beyond the capability and responsibility of this or any other single nation. An era of unprecedented cooperation and commitment is essential" (Barney, 1980, p. 4).

The government's conclusion, which required a global solution, was quite surprising, because their computer models were flawed. Although the individual agencies had access to vast amounts of information, each agency developed its own computer model. This made the simultaneous study of all factors by any agency impossible. Each agency also assumed that the inputs required by its model would be met irrespective of the results being obtained in other simulations. If all the models had been integrated, the projections in *Global 2000* would have been less optimistic. Integration would have intensified and hastened the consequences of the predicted trends.

BEYOND THE LIMITS

Beyond the Limits (Meadows, et al., 1992), the twentieth anniversary successor to *The Limits to Growth*, is the most recent, computer-generated assessment of the predicament of humankind. In this book, the authors return to a one-world simulation. They believe that humankind's approach to planetary limits must be

studied, because no nation is completely insulated from what occurs in the rest of the world.

Beyond the Limits concludes that conditions have not improved in the last 20 years. "The human world is beyond its limits" (Meadows, *et al.*, 1992, p. xv). Overshoot and erosion of the carrying capacity are the most likely outcomes of a continuation of current policies. To have a sustainable future, humankind must scale back its expectations.

The global economy called for in *Mankind at the Turning Point* has not developed. Continued growth has not solved the problems of poverty and unemployment. Between 1970 and 1990, industrial output grew faster than population, but most of the economic growth occurred in industrialized countries whose populations were approaching stability and where the economic base was already large. Basic needs were being met in these countries, resulting in high rates of savings and investment. In the less-industrialized countries, the rapidly growing populations consumed any economic gain so that poverty was perpetuated, fueling even greater population increases.

Agricultural output has increased by a factor of two to three and could adequately feed the world's population. In the less-industrialized countries, large population increases coupled with storage and distribution problems have kept food per capita low and largely unchanged. In Africa, food per capita is decreasing.

Without change, food will become the global limiting factor. The limits to food production are land, water, soil nutrients, and sinks for agricultural pollutants. Throughout human history, land has been abundant. Only in the last 35 years has exponential population growth led to a shortage. In some regions, these limits (e.g., water for irrigation) have been exceeded, and the agricultural base is being degraded; i.e., "...agricultural success has resulted primarily in more people and more deserts" (Meadows, *et al.*, 1992, p. 40). Yet, remedial conservation techniques, such as alley cropping and agroforestry, are known. The problem is not technical, but social. Societies have not implemented the solution.

The computer model in *Beyond the Limits*, World3/91, an upgraded version of the program used in *The Limits to Growth*, is based on four physical and biological limits: the amount of cultivatable land (3.2 billion hectares), the yield per land unit (6,500 kg grain/hectare), the nonrenewable resource supply (200 years at 1990 extraction rates), and pollution absorption (a variable which is difficult to quantify). The model has a strong tendency to overshoot and collapse due to the delays inherent in natural systems (e.g., pollutants become noticeably harmful only at sufficiently high concentrations) and the inability of these systems to repair themselves quickly, if at all, after severe degradation (e.g., since extinction is forever, what would a regenerated rain forest which had lost a significant number of its species look like?). Even these conclusions may be overly optimistic, because societal changes such as war, strikes, disease, trade embargoes, or political maneuvering are not accounted for in the model.

Hungry people tend to permanently degrade their environment (e.g., desertification and acidification). Delays in implementing new technologies are too long to prevent the degradation of the environment. Delays result in overshoot, and degradation results in collapse. The societies that are least capable of technological change are the ones that are impacted first.

These conclusions are summarized in the following statement (Meadows, *et al.*, 1992, p. 138):

Any population-economy-environment system that has feedback delays and slow physical responses, that has thresholds and erosive mechanisms, is literally *unmanageable*. No matter how brilliant its technologies, no matter how efficient its economy, no matter how wise its decision makers, it simply can't steer itself away from the hazards unless it tests its limits very, very slowly. If it constantly tries to accelerate, it is bound to overshoot. [emphasis in original]

To prepare, humankind must think decades ahead.

When deliberate constraints on growth are implemented by society (scenario 10 in *Beyond the Limits*), a sustainable equilibrium is possible. If implemented in 1995, this sustainable society would include 7.7 billion people with life expectancies of 80 years. Had these constraints on growth been implemented twenty years ago (1975), the world population would have stabilized at a lower number, allowing for more goods per capita, producing less pollution, and having more remaining nonrenewable resources. (Humankind will find it difficult, if not impossible, to return to this point.) If change is delayed until 2015, collapse can no longer be forestalled. The model cannot be used to study whether or not recovery would occur, because accurate point predictions about regions and times are not possible. Total collapse may be simply unavoidable.

The conclusions reached in *Beyond the Limits* mandate three actions. First, the consumption of material goods and energy must be scaled back, if the world system is not going to collapse. The world's sources of raw materials are drying up, and the world's sinks for waste disposal are overflowing. Second, as the rates of material consumption and population growth are decreased, the efficiency of material and energy usage must be increased. The emphasis will be on making durable goods and efficient machines. Third, global equilibrium can only be achieved if humankind emphasizes the equality of people and de-emphasizes the output of material goods (i.e., humankind must emphasize qualitative, or structural, improvement and not quantitative, or material, growth). Poverty must not be allowed to exist (also see Commoner, 1992) — "...society must provide material sufficiency and security for all" (Meadows, *et al.*, 1992, p. 211). As a result, technology and culture would bloom.

The major hurdles to implementing this system are political and psychological. A discussion of environmental issues is often avoided, because these issues are too politically and emotionally charged. Who is to blame? Who should take care of the problem? Meadows, *et al.* (1992, p. 191) note that:

The third way to respond [after denial and attempting to shore up the system] is to step back and acknowledge that the human socioeconomic system as currently structured is unmanageable, has overshoot its limits, and is headed for collapse, and, therefore, to *change the structure of the system*. [emphasis in original]

People are taught to consume and that growth is good. However, **more** is no longer better. We must decide when we have **enough** things and **enough** people and look forward to a period of global sustainability.

SUMMARY

As can be seen in this brief review, little has changed in the human condition over the last 20 to 25 years. The conclusions reached in each of these books still confront us. First, all the people of the earth must be respected and treated as members of a large interconnected family. Armed confrontation in the Near East, Yugoslavia, and Somalia show how far we are from achieving this goal. Second, a global economy must be developed that provides security for all people on all continents. Although painful, some jobs must be exported from the developed countries to help create a global economy. Third, economic growth is no longer a blessing. We should not worry excessively about the creation of new manufacturing jobs but look to the service sector. If growth is to occur in the service sector, the pay must be higher to prevent increasing the ranks of the working poor. Finally, educators must play an ever increasing role in fulfilling human potential. Teachers are going to be asked to make everyone happy and enlightened at a time when it is difficult to convince some students it is their best interest to study and to learn. Of course, all of these changes should be instituted by 1995.

These issues should not be introduced dogmatically into the classroom, because they represent only one point of view. An informal discussion of this manuscript in a class of upper division biology majors showed that a single, unanimous opinion is not possible. These topics do offer the possibility for some interesting debates from a position that is nearly always neglected in introductory textbooks. Global models provide a stimulus by which our students' growing environmental concerns can be elevated to a global level. When the students feel they can make a difference, they are empowered for change.

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