

THE FUTURE OF SUSTAINABILITY
An Anthology Edited by Marco Keiner
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The following is my contribution to this anthology.

Albert A. Bartlett

REFLECTIONS ON SUSTAINABILITY,

**POPULATION GROWTH,
AND THE ENVIRONMENT - 2006**

Albert A. Bartlett

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ABSTRACT

The related terms, "sustainable" and "sustainability" are popularly used to describe a wide variety of activities which are generally ecologically laudable but which may not be sustainable. An examination of major reports reveals contradictory uses of the terms. An attempt is made here to give a firm and unambiguous definition to the concept of sustainability and to translate the definition into a series of laws which, it is hoped, will clarify the logical implications of sustainability. The laws should enable one to read the many publications on sustainability and help one to decide whether the publications are seeking to illuminate or to obfuscate.

INTRODUCTION

In the 1980s it became apparent to thoughtful individuals that populations, poverty, environmental degradation, and resource shortages were increasing at a rate that could not long be continued. Perhaps most prominent among the publications that identified these problems in hard quantitative terms and then provided extrapolations into the future, was the book *Limits to Growth* (Meadows, *et. al.* 1972) which simultaneously evoked admiration and consternation. The consternation came from traditional "Growth is Good" groups all over the world. Their rush to rebuttal was immediate and urgent, prompted perhaps by the thought that the message of *Limits* was too terrible to be true. (Cole, *et. al.* 1973) As the message of *Limits* faded, the concept of limits became an increasing reality with which people had to deal. Perhaps, as an attempt to offset or deflect the message of *Limits*, the word "sustainable" began to appear as an adjective that modified common terms. It was drawn from the concept of "sustained yield" which is used to describe agriculture and forestry when these enterprises are conducted in such a way that they could be continued indefinitely, i.e., their yield could be sustained. The use of the new term "sustainable" provided comfort and reassurance to those who may momentarily have wondered if possibly there were limits. The word was soon applied in many areas, and with less precise meaning, so that for example, with little visible change, "development" became "sustainable development," etc. One would see political leaders using the term "sustainable" to describe their goals as they worked hard to create more jobs, to increase population, and to increase rates of consumption of energy and resources. In the manner of Alice in Wonderland, and without regard for accuracy or consistency, "sustainability" seems to have been redefined flexibly to suit a variety of wishes and conveniences.

THE MEANING OF SUSTAINABILITY

First, we must accept the idea that "sustainable" has to mean "for an unspecified long period of time."

Second, we must acknowledge the mathematical fact that steady growth (a fixed percent per year) gives very large numbers in modest periods of time. For example, a population of 10,000 people growing at 7 % per year will become a population of 10,000,000 people in just 100 years. (Bartlett 1978)

From these two statements we can see that the term "sustainable growth" implies "increasing endlessly." This means that the growing quantity will tend to become infinite in size. The finite size of resources, ecosystems, the environment, and the Earth, lead to the most fundamental truth of sustainability:

**When applied to material things,
the term "sustainable growth" is an oxymoron.**

(It is possible to have sustainable growth of non-material things such as inflation.)

Daly has pointed out that "sustainable development" may be possible if materials are recycled to the maximum degree possible, and if one does not have growth in the annual material throughput of the economy. (Daly 1994)

THE USE OF THE TERM "SUSTAINABLE"

A sincere concern for the future is certainly the factor that motivates many who make frequent use of the word, "sustainable." But there are cases where one suspects that the word is used carelessly, perhaps as though the belief exists that the frequent use of the adjective "sustainable" is sufficient to create a sustainable society.

"Sustainability" has become big-time. University centers and professional organizations have sprung up using the word "sustainable" as a prominent part of their names. In some cases, these big-time operations may be illustrative of what might be called the "Willie Sutton School of research management." (Sutton)

For many years, studies had been conducted on ways of improving the efficiency with which energy is used in our society. These studies have been given new luster by referring to them now as studies in the "sustainable use of energy."

The term "sustainable growth" is used by our political leaders even though the term is clearly an oxymoron. In a recent report from the Environmental Protection Agency we read that:

President Clinton and Vice President Gore wrote in *Putting People First*, "We will renew America's commitment to leave our children a better nation - - a nation whose air, water, and land are unspoiled, whose natural beauty is undimmed, and whose leadership for sustainable global growth is unsurpassed." (EPA 1993)

We even find a scientist writing about "sustainable growth:"

...the discussions have centered around the factors that will determine [a] level of sustainable growth of agricultural production. (Abelson 1990)

And so we have a spectrum of uses of the term "sustainable." At one end of the spectrum, the term is used with precision by people who are introducing new concepts as a consequence of thinking profoundly about the long-term future of the human race. In the middle of the spectrum, the term is simply added as a modifier to the names and titles of very beneficial studies in efficiency, etc. that have been in progress for years. Near the other end of the spectrum, the term is used as a placebo. In some cases the term may be used mindlessly (or possibly with the intent to deceive) in order to try to shed a favorable light on continuing activities that may or may not be capable of continuing for long periods of time. At the very far end of the spectrum, we see the term used in a way that is oxymoronic.

Let us examine the use of the term "sustainable" in some major environmental reports.

SUSTAINABILITY

The terms "sustainable" and "sustainability" burst into the global lexicon in the 1980s as the electronic news media made people increasingly aware of the growing global problems of overpopulation, drought, famine, and environmental degradation that had been the subject of *Limits to Growth* in the early 1970s, (Meadows, et.al. 1972). A great increase of awareness came with the publication of the report of the United Nations World Commission on Environment and Development, the Brundtland Report, which is available in bookstores under the title *Our Common Future*. (Brundtland 1987)

In graphic and heart-wrenching detail, the Report places before the reader the enormous problems and suffering that are being experienced with growing intensity every day throughout the underdeveloped world. In the foreword, before there was any definition of "sustainable," there was the ringing call:

What is needed now is a new era of economic growth - growth that is forceful and at the same time socially and environmentally sustainable. (p. xii)

One should be struck by the fact that here is a call for "economic growth" that is "sustainable". One has to ask if it is possible to have an increase in economic activity (growth) without having increases in the rates of consumption of non-renewable resources? If so, under what conditions can this happen? Are we moving toward those conditions today? What is meant by the undefined terms, "socially sustainable" and "environmentally sustainable?"

As we have seen, these two concepts of "growth" and "sustainability" are in conflict with one another, yet the Brundtland Report calls for both. The use of the word "forceful" would seem to imply "rapid," but if this is the intended meaning, it would just heighten the conflict.

A few pages later in the Report we read:

Thus sustainable development can only be pursued if population size and growth are in harmony with the changing productive potential of the ecosystem. (p. 9)

One begins to feel uneasy. "Population size and growth" are vaguely identified as possible problem areas, but we don't know what the Commission means by the phrase "in harmony with...?" It can mean anything. By page 11 the Commission acknowledges that population growth is a serious problem, but then:

The issue is not just numbers of people, but how those numbers relate to available resources. Urgent steps are needed to limit extreme rates of population growth.
[emphasis added]

The suggestion that "The issue is not just numbers of people" is alarming. This denial of the importance of numbers has become central to many of the programs that deal with sustainability. Neither "limit" nor "extreme" are defined, and so the sentence gives the impression that most population growth is acceptable and that only the undefined "extreme rates of population growth" need to be dealt with by some undefined process of limiting. By page 15 we read that:

A safe, environmentally sound, and economically viable energy pathway that will sustain human progress into the distant future is clearly imperative.

Here we see the recognition that energy is a major long-term problem, yet we see no recognition of the enormous technical and economic difficulties that can reasonably be expected in the search for an "environmentally sound and economically viable energy pathway." The Report does recognize that "sustainable" has to mean "into the distant future."

As the authors of the Report searched for solutions, they called for large efforts to support "sustainable development." The Report's definition of "sustainable development" has been widely used by others. It appears in the first sentence of Chapter 2, (p. 43):

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

This definition, coupled with the earlier statement of the need to "sustain human progress into the distant future," are crucial for an understanding of the term, "sustainable development."

Unfortunately, the definition gives no hint regarding the courses of action that could be followed to meet the needs of the present, but which, in doing so, would not limit the ability of generations, throughout the distant future, to meet their own needs. It seems obvious that non-renewable resources consumed now will not be available for consumption by future generations.

The Commission recognizes that there is a conflict between population growth and development: (p. 44)

An expansion in numbers [of people] can increase the pressure on resources and slow the rise in living standards in areas where deprivation is widespread. Though the issue is not merely one of population size, but of the distribution of resources, sustainable development can only be pursued if demographic developments are in harmony with the changing productive potential of the ecosystem.

Can the Commission mean that population growth slows the rise of living standards *only* "in areas where deprivation is widespread?" This statement recites again the politically correct assertion that "the issue is not merely one of population size." The Commission shifts the blame for the problems to presumed faults in the distribution of resources. The Commission then speaks of "demographic developments," whatever that may mean, which must be "in harmony with...", whatever that means. If one accepts reports of the decline of "global productive potential of ecosystems" due to deforestation, the loss of topsoil, pollution, etc., (Kendall and Pimentel 1994) then the "in harmony with..." could mean that population also will have to decline. But the Commission is very careful not to suggest the need for a decline in population.

These quotations are thought to be representative of the vague and contradictory messages that are in this important report. As the Report seeks to address severe global problems, it clearly tries to marginalize the role of population size as an agent of causation of these severe global problems.

The Brundtland Commission Report's discussion of "sustainability" is both optimistic and vague. The Commission probably felt that, in order to be accepted, the discussion had to be

optimistic, but given the facts, it was necessary to be vague and contradictory in order not to appear to be pessimistic.

CARRYING CAPACITY

The term "carrying capacity," long known to ecologists, has also recently become popular. It "refers to the limit to the number of humans the earth can support in the long term without damage to the environment." (Giampietro, et. al. 1992)

The concept of carrying capacity is central to discussions of population growth. The concept has been examined by Cohen in a book *How Many People can the Earth Support?* (Cohen 1995) Cohen makes a scholarly examination of many past estimates of the carrying capacity of the Earth, and concludes that it is not possible to say how many people the Earth can support. Obviously, it depends on the desired average standard of living.

There is no closed formula for calculating the carrying capacity of the Earth, even for some stated average standard of living. This means that any calculated estimate of the carrying capacity of the Earth may be challenged and will certainly be ignored.

Human activities have already caused great change in the global environment. May observes that (May 1993):

...the scale and scope of human activities have, for the first time, grown to rival the natural processes that built the biosphere and that maintain it as a place where life can flourish.

Many facts testify to this statement. It is estimated that somewhere between 20 and 40 percent of the earth's primary productivity, from plant photosynthesis on land and in the sea, is now appropriated for human use.

An impact on the global environment of this magnitude is properly the cause for alarm.

The inevitable and unavoidable conclusion is that if we want to stop the increasing damage to the global environment, as a minimum, we must stop population growth.

So, instead of trying to calculate how many people the Earth can support, we should instead, focus on the question of why should we have more population growth. This is nicely framed in the challenge:

Can you think of any problem, on any scale, from microscopic to global,
Whose *long-term* solution is in any *demonstrable* way,
Aided, assisted, or advanced, by having larger populations
At the local level, the state level, the national level, or globally?

THE FINAL WORD ON THE CARRYING CAPACITY OF THE EARTH

Even though we cannot calculate a carrying capacity for the Earth, we have an unambiguous indication that the world population has already exceeded this carrying capacity. We are observing global warming. *If any part of the observed global warming is due to the activity of humans, then this is positive proof that the present population of the Earth, living as we do, is greater than the carrying capacity of the Earth.*

POPULATION AND THE ENVIRONMENTAL PROTECTION AGENCY

The U.S. Environmental Protection Agency has done many constructive and beneficial things. The policies, actions, and leadership of the Agency are crucial if we are to have any hope of achieving a sustainable society. In a recent report from the Agency, we read:

In view of the increasing national and international interest in sustainable development, Congress has asked the Environmental Protection Agency (EPA) to report on its efforts to incorporate the concepts of sustainable development into the Agency's operations.

The Report (EPA 1993) is both encouraging and distressing. It is encouraging to read of all of the many activities of the Agency which help protect the environment. It is distressing to search in vain through the Report for acknowledgment that population growth is at the root of most of the problems which the Agency seeks to address. While the Brundtland Report says that population growth is not the central problem, the EPA report avoids making this allegation. But the EPA report makes only a very few minor references to the environmental problems that arise as a direct consequence of population growth.

The EPA report speaks of an initiative to pursue sustainable development in the Central Valley of California:

where many areas are experiencing rapid urban growth and associated environmental problems...

A stronger emphasis on sustainable agricultural practices will be a key element in any long-term solutions to problems in the area.

There is no way that "A stronger emphasis on sustainable agricultural practices" can stop the "rapid urban growth" that is destroying farmland! An emphasis on agriculture cannot solve the problem. To solve the problems, one must stop the "rapid urban growth" which causes the problems. It is pointless to focus on the development of "sustainable agricultural practices" when the Agency expects that agriculture will soon be displaced by the "rapid urban growth."

This quotation of a minor section of the EPA report make it clear that the EPA understands the origin of environmental problems. Here is an agency that seeks to solve problems caused by population growth, yet when it sets forth its recommended solutions, stopping population growth is not mentioned. Is this professionally ethical?

THE MARGINALIZATION OF MALTHUS

We have seen how major national and international reports misrepresent and downplay (marginalize) the quantitative importance of the arithmetic of population sizes and growth. The

recognition of the importance of quantitative analysis of population sizes was first popularized by Thomas Malthus two hundred years ago, (Appleman 1976) but the attempted marginalization of Malthus goes on today at all levels of society.

In an article, "The Population Explosion is Over" Ben Wattenberg finds support for the title of his article in the fact that fertility rates are declining in parts of the world. (Wattenberg 1997) Most of the countries of Europe are (2004) at zero population growth or negative population growth, and fertility rates in parts of Asia, have declined dramatically. Rather than rejoicing over the clear evidence of this movement in the direction of sustainability, Wattenberg sounds the alarm over the "birth dearth" as though this fertility decline requires an immediate reversal.

The most extreme case is that of Julian Simon who advocates continued population growth long into the future. Writing in the newsletter of a major think tank in Washington, D.C., Simon says:

We have in our hands now - actually in our libraries - the technology to feed, clothe, and supply energy to an ever-growing population for the next 7 billion years... Even if no new knowledge were ever gained...we would be able to go on increasing our population forever. (Simon 1995)

It has been noted that a spherical earth is finite, but a flat earth can be infinite in extent. So if Simon is correct, we must be living on a flat earth. (Bartlett 1996)

THE WORLD'S WORST POPULATION PROBLEM

Echoing a view expressed earlier by the Ehrlichs (Ehrlich 1992) Bartlett points out that because of the high *per capita* consumption of resources in the U.S., *we in the U.S. have the world's worst population problem!* (Bartlett 1997) Many Americans think of the population problem is a problem only of "those people" in the undeveloped countries, but this serves only to draw attention away from the difficulties of dealing with our own problems here in the U.S. It is easier to tell a neighbor to mow his / her yard than it is for us to mow our own yard. With regard to other countries, we can offer family planning assistance on request, but in those countries we have no jurisdiction or direct responsibility. Within our own country we have complete jurisdiction and responsibility, yet we fail to act to help solve our own problem. In a speech at the University of Colorado, then U.S. Senator Tim Wirth observed that the best thing we in the U.S. can do to help other countries stop their population growth is to set an example and stop our own population growth here in the U.S.

There can be no question about the difficulty that we will have to achieve zero growth of the population of the U.S. An examination of the simple numbers makes the difficulty clear. In particular, population growth has "momentum" which means that if one makes a sudden change in the fertility rate in a society, the full effect of the change will not be realized until every person has died who was living when the change was made. Thus it takes approximately 70 years to see the full effect of a change in the fertility rate. (Bartlett & Lytwak 1995)

POPULATION GROWTH NEVER PAYS FOR ITSELF

There are many encouraging signs from communities around the U.S. that indicate a growing awareness of the local problems of continued unrestrained growth of populations,

because population growth in our communities never pays for itself. Taxes and utility costs must increase in order to pay for the growth. In addition, growth brings increased levels of congestion, pollution and frustration.

The positive proof that population growth does not pay for itself is seen in the budget crises of many of the U.S. states. During the 1990s the economy was “healthy,” which means it was growing rapidly. If the growth had paid for itself, the state governments should have accumulated financial reserves to help get through a decline in the national economy. When the economy declined around the turn of the century, the fiscal obligations that had accumulated during the good times came due, and there were inadequate funds to meet the needs.

Fodor (1999) gives many detailed examples from communities all over the U.S. showing how the population growth falls far short of paying for itself.

The Tragedy of the Commons (Hardin 1968) makes it clear that there will always be large opposition to programs of making population growth pay for itself. Those who profit from growth will use their considerable resources to convince the community that the community should pay the costs of growth. In our communities, making growth pay for itself could be a major tool to use in stopping the population growth.

PSEUDO SOLUTIONS: GROWTH MANAGEMENT - SMART GROWTH

The claim is often made that smart growth “will save the environment.” It is worth remembering that:

Smart growth is better than dumb growth, but
Smart growth destroys the environment; and
Dumb growth destroys the environment.
The difference is that smart growth destroys the environment with good taste

So it's a little like buying a ticket on the TITANIC.
If you're smart you go first class.
If you're dumb you go steerage.
But either way, the result is the same.

PSEUDO SOLUTIONS: REGIONAL PLANNING

As populations of cities grow, the call is made for “regional solutions” to the many problems created by growth. This has two negative effects:

- 1) Regional planning dilutes democracy. A citizen participating in public affairs has five times the impact in his / her city of 20,000 as he / she would have in a region of 100,000 people.
- 2) The regional “solutions” are usually designed to accommodate the predicted growth and hence these “solutions” encourage more growth. In the spirit of Eric Sevareid's Law (below), regional “solutions” enlarge the problems rather than solving them.

One concludes that regional solutions to problems caused by growth will make lives better for people only if the growth is stopped. If the regional solutions permit or encourage more growth, then the regional planning has made things worse.

WAR AND PEACE

At the local or state levels, there is an interesting parallel between the promotion of growth (unsustainability) and the promotion of war, both of which can be very profitable for high level people but are very expensive for everyone else.

The waging of war is the sole enterprise of large military establishments. Even the meanest mind knows what has to be done to win a war; "One has to beat the opponent," after which one can have a large party to celebrate the victory, pass out the medals, and then start preparing for the next war. Promoting community growth is quite similar. The promotion of growth is the sole enterprise of large municipal and state establishments, both public and private. It does not take much of a mind to know that victory in the growth war requires that your community beat competing communities to become the location of new factories and businesses. Campaigns and battles are planned and, when a factory comes, there is a large party to celebrate the victory and pass out the awards. Then the community warriors start fighting for even more new factories.

In contrast, winning the peace is quite different. Even the best minds don't know for sure the best way to "win the peace." Compared to the groups that promote war, the public agencies that are devoted to maintaining peace are miniscule. In the effort to maintain peace, there is no terminal point at which a party is in order where all can celebrate the fact that, "We won the peace!" Winning the peace takes eternal vigilance. Protecting the community environment from the ravages of growth is quite the same. The best minds don't know for sure the best way to do it. There are few public establishments whose sole role is to preserve the environment. One can postpone assaults on the environment, but by and large, it takes eternal vigilance of concerned citizens, who, at best, can only reduce the rate of loss of the environment. There is no terminal time at which one can have a party to celebrate the fact that, "We have saved the environment!"

LAWS RELATING TO SUSTAINABILITY

Let us be specific and state that both "Carrying Capacity" and "Sustainable" imply "for the period in which we hope humans will inhabit the earth." This means "for many millennia."

Many prominent individuals have given postulates and laws relating to population growth and sustainability.

THE TWO "POSTULATA" OF THOMAS MALTHUS

The reverend Thomas Malthus used these two assumptions as the basis of his famous essay two hundred years ago.

First, That food is necessary to the existence of man.

Secondly, That the passion between the sexes is necessary and will remain nearly in its present state. (Appleman, 1976)

BOULDING'S THREE THEOREMS

These theorems are from the work of the eminent economist Kenneth Boulding. (1971)

First Theorem: "The Dismal Theorem" If the only ultimate check on the growth of population is misery, then the population will grow until it is miserable enough to stop its growth.

Second Theorem: "The Utterly Dismal Theorem" This theorem states that any technical *improvement* can only relieve misery for a while, for so long as misery is the only check on population, the [technical] improvement will enable population to grow, and will soon enable *more* people to live in misery than before. The final result of [technical] improvements, therefore, is to increase the equilibrium population which is to increase the total sum of human misery.

Third Theorem: "The moderately cheerful form of the Dismal Theorem" Fortunately, it is not too difficult to restate the Dismal Theorem in a moderately cheerful form, which states that if something else, other than misery and starvation, can be found which will keep a prosperous population in check, the population does not have to grow until it is miserable and starves, and it can be stably prosperous.

Boulding continues:

Until we know more, the Cheerful Theorem remains a question mark. Misery we *know* will do the trick. This is the only sure-fire automatic method of bringing population to an equilibrium. Other things *may* do it.

In another context, Boulding observed that:

The economic analysis I presented earlier indicates that the major priority, and one in which the United Nations can be of great utility, is a world campaign for the reduction of birth rates. This, I suggest, is more important than any program of foreign aid and investments. Indeed, if it is neglected, all programs of aid and investment will, I believe, be ultimately self-defeating and will simply increase the amount of human misery. (Boulding 1971, p. 361)

LAWS OF SUSTAINABILITY

The Laws that follow are offered to define the term "sustainability." In some cases these statements are accompanied by corollaries that are identified by capital letters. They all apply for populations and rates of consumption of goods and resources of the sizes and scales found in the world in 2005, and may not be applicable for small numbers of people or to groups in primitive tribal situations.

These Laws are believed to hold rigorously.

The list is but a single compilation, and hence may be incomplete. Readers are invited to communicate with the author in regard to items that should or should not be in this list.

First Law: Population growth and / or growth in the rates of consumption of resources cannot be sustained.

- A) A population growth rate less than or equal to zero and declining rates of consumption of resources are a necessary, but not a sufficient, condition for a sustainable society.
- B) Unsustainability will be the certain result of any program of "development," that does not plan the achievement of zero (or a period of negative) growth of populations and of rates of consumption of resources. This is true even if the program is said to be "sustainable."
- C) The research and regulation programs of governmental agencies that are charged with protecting the environment and promoting "sustainability" are, in the long run, irrelevant, unless these programs address vigorously and quantitatively the concept of carrying capacities and unless the programs study in depth the demographic causes and consequences of environmental problems.
- D) Societies, or sectors of a society, that depend on population growth or growth in their rates of consumption of resources, are unsustainable.
- E) Persons who advocate population growth and / or growth in the rates of consumption of resources are advocating unsustainability.
- F) Persons who suggest that sustainability can be achieved without stopping population growth are misleading themselves and others.
- G) Persons whose actions directly or indirectly cause increases in population or in the rates of consumption of resources are moving society away from sustainability.
- H) The term "Sustainable Growth" is an oxymoron.
- I) In terms of population sizes and rates of resource consumption, "The only smart growth is no growth." (Hammond, 1999)

Second Law: In a society with a growing population and / or growing rates of consumption of resources, the larger the population, and / or the larger the rates of consumption of resources, the more difficult it will be to transform the society to the condition of sustainability.

Third Law: The response time of populations to changes in the human fertility rate is the average length of a human life, or approximately 70 years. (Bartlett and Lytwak 1995) [This is called "population momentum."]

- A) A nation can achieve zero population growth if:
 - a) the fertility rate is maintained at the replacement level for 70 years, and
 - b) there is no net migration during the 70 years.

During the 70 years the population continues to grow, but at declining rates until the growth finally stops after approximately 70 years.

- B) If we want to make changes in the total fertility rates so as to stabilize the population by the mid - to late 21st century, we must make the necessary changes now.
- C) The time horizon of political leaders is of the order of two to eight years.
- D) It will be difficult to convince political leaders to act now to change course, when the full results of the change may not become apparent in the lifetimes of those leaders.

Fourth Law: The size of population that can be sustained (the carrying capacity) and the sustainable average standard of living of the population are inversely related to one another. (This must be true even though Cohen asserts that the numerical size of the carrying capacity of the Earth cannot be determined, (Cohen 1995))

- A) The higher the standard of living one wishes to sustain, the more urgent it is to stop population growth.
- B) Reductions in the rates of consumption of resources and reductions in the rates of production of pollution can shift the carrying capacity in the direction of sustaining a larger population.

Fifth Law: One cannot sustain a world in which some regions have high standards of living while others have low standards of living.

Sixth Law: All countries cannot simultaneously be net importers of carrying capacity.

- A) World trade involves the exportation and importation of carrying capacity.

Seventh Law: A society that has to import people to do its daily work (“we can’t find locals who will do the work.”) is not sustainable.

Eighth Law: Sustainability requires that the size of the population be less than or equal to the carrying capacity of the ecosystem for the desired standard of living.

- A) Sustainability requires an equilibrium between human society and dynamic but stable ecosystems.
- B) Destruction of ecosystems tends to reduce the carrying capacity and / or the sustainable standard of living.
- C) The rate of destruction of ecosystems increases as the rate of growth of the population increases.

D) Affluent countries, through world trade, destroy the ecosystems of less developed countries.

E) Population growth rates less than or equal to zero are necessary, but are not sufficient, conditions for halting the destruction of the environment. This is true locally and globally.

Ninth Law: (The lesson of "The Tragedy of the Commons") (Hardin 1968): The benefits of population growth and of growth in the rates of consumption of resources accrue to a few; the costs of population growth and growth in the rates of consumption of resources are borne by all of society.

A) Individuals who benefit from growth will continue to exert strong pressures supporting and encouraging both population growth and growth in rates of consumption of resources.

B) The individuals who promote growth are motivated by the recognition that growth is good for them. In order to gain public support for their goals, they must convince people that population growth and growth in the rates of consumption of resources, are also good for society. [This is the Charles Wilson argument: if it is good for General Motors, it is good for the United States.] (Yates 1983)

Tenth Law: Growth in the rate of consumption of a non-renewable resource, such as a fossil fuel, causes a dramatic decrease in the life-expectancy of the resource.

A) In a world of growing rates of consumption of resources, it is seriously misleading to state the life-expectancy of a non-renewable resource "at present rates of consumption," i.e., with no growth. More relevant than the life-expectancy of a resource is the expected date of the peak production of the resource, i.e. the peak of the Hubbert curve. (Hubbert 1972)

B) It is intellectually dishonest to advocate growth in the rate of consumption of non-renewable resources while, at the same time, reassuring people about how long the resources will last "at present rates of consumption." (zero growth)

Eleventh Law: The time of expiration of non-renewable resources can be postponed, possibly for a very long time, by:

i) technological improvements in the efficiency with which the resources are recovered and used

ii) using the resources in accord with a program of "Sustained Availability," (Bartlett 1986)

iii) recycling

iv) the use of substitute resources.

Twelfth Law: When large efforts are made to improve the efficiency with which resources are used, the resulting savings are easily and completely wiped out by the added resources that are consumed as a consequence of modest increases in population.

- A) When the efficiency of resource use is increased, the consequence often is that the "saved" resources are not put aside for the use of future generations, but instead are used immediately to encourage and support larger populations.
- B) Humans have an enormous compulsion to find an immediate use for all available resources.

Thirteenth Law: The benefits of large efforts to preserve the environment are easily canceled by the added demands on the environment that result from small increases in human population.

Fourteenth Law: (Second Law of Thermodynamics) When rates of pollution exceed the natural cleansing capacity of the environment, it is easier to pollute than it is to clean up the environment.

Fifteenth Law: (Eric Sevareid's Law); The chief cause of problems is solutions. (Sevareid 1970)

- A) This law should be a central part of higher education, especially in engineering.

Sixteenth Law: Humans will always be dependent on agriculture.
(This is the first of Malthus' two postulata.)

- A) Supermarkets alone are not sufficient.
- B) The central task in sustainable agriculture is to preserve agricultural land.
The agricultural land must be protected from losses due to things such as:
 - i) Urbanization and development
 - ii) Erosion
 - iii) Poisoning by chemicals

Seventeenth Law: If, for whatever reason, humans fail to stop population growth and growth in the rates of consumption of resources, Nature will stop these growths.

- A) By contemporary western standards, Nature's method of stopping growth is cruel and inhumane.

B) Glimpses of Nature's method of dealing with populations that have exceeded the carrying capacity of their lands can be seen each night on the television news reports from places where large populations are experiencing starvation and misery.

Eighteenth Law: In local situations within the U.S., creating jobs increases the number of people locally who are out of work.

A) Newly created jobs in a community temporarily lowers the unemployment rate (say from 5% to 4%), but then people move into the community to restore the unemployment rate to its earlier higher value (of 5%), but this is 5% of the larger population, so more individuals are out of work than before.

Nineteenth Law: Starving people don't care about sustainability.

A) If sustainability is to be achieved, the necessary leadership and resources must be supplied by people who are not starving.

Twentieth Law: The addition of the word "sustainable" to our vocabulary, to our reports, programs, and papers, to the names of our academic institutes and research programs, and to our community initiatives, is not sufficient to ensure that our society becomes sustainable.

Twenty-First Law: Extinction is forever.

SO WHERE DO WE GO FROM HERE?

The challenge of making the transition to a sustainable society is enormous, in part because of a major global effort to keep people from recognizing the centrality of population growth to the enormous problems of the U.S. and the world.

On the global scale, we need to support family planning throughout the world, and we should generally restrict our foreign aid to those countries that make continued demonstrated progress in reducing population growth rates and sizes.

The immediate task is to restore numeracy to the population programs in the local, national and global agendas.

On the national scale, we can work for the selection of leaders who will recognize that population growth is the major problem in the U.S. and who will initiate a national dialog on the problem. With a lot of work at the grassroots, our system of representative government will respond.

On the local and national levels, we must focus serious attention and large fiscal resources on the development of renewable energy sources.

On the local and national levels, we need to work to improve social justice and equity

On the community level in the U.S., we should work to make growth pay for itself.

BOULDING ON MALTHUS

In writing about Malthus' essay on population, Kenneth Boulding observed that:

the essay, punctures the easy optimism of the utopians of any generation. But by revealing the nature of at least one dragon that must be slain before misery can be abolished, its ultimate message is one of hope, and the truth, however unpleasant, tends "not to create despair, but activity" of the right kind. (Boulding 1971, p. 142)

A THOUGHT FOR THE FUTURE

When competing "experts" recommend diametrically opposing paths of action regarding resources, carrying capacity, sustainability, and the future, we serve the cause of sustainability by choosing the conservative path, which is defined as the path that would leave society in the less precarious position in case the chosen path turns out to be the wrong path.

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