

## ENVIRONMENTAL SCIENCE IN AN ERA OF SCARCE RESOURCES

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*It is the mark of an instructed mind to rest satisfied with the degree of precision to which the nature of the subject admits and not to seek exactness when only an approximation of the truth is possible.*

Aristotle

*First have a definite, clear practical ideal; a goal, an objective. Second have the necessary means to achieve your ends; wisdom, money, materials, and methods. Third adjust all your means to that end.*

Aristotle

*How serious is the threat to the environment? Here is one measure of the problem: all we have to do to destroy the planet's climate and biota and leave a ruined world to our children and grandchildren is to keep doing exactly what we are doing today, with no growth in human population or the world economy. Just continue to release greenhouse gases at current rates, just continue to impoverish ecosystems and release toxic chemicals at current rates, and the world in the latter part of this century won't be fit to live in.*

James Gustave Speth (2008, p. x)

The global economy is based on cheap, readily available energy, and conventional oil production may have peaked in 2005-2006. Recent studies conclude that global coal production will peak and begin to decline in 10 to 20 years (Heinberg 2007, pp. 1, 3). Heinberg (2007, p. 6) notes: ". . . the general picture is inescapable: it is one of mutually interacting instances of overconsumption and emerging scarcity." This realization (the beginning of a period of overall societal contraction) is strengthened as humans come to understand that so many peaks occurring together are no happenstance. They are all causally related by the historic reality of the past 20 years that cheap, abundant energy from fossil fuels has driven technological invention, increases in total and per capita resource extraction and consumption (including food production), and population growth. Heinberg (2007, p. 14) also notes: "As available energy declines, our ability to alter the environment will do so as well. However, if we make no deliberate attempt to control our impact on the biosphere, the peak will be a very high one and we will do an immense amount of damage along the way."

### Corporations and Sovereign Nations

Within a few decades, both national and corporate structures will have crumbled for lack of fuel (Heinberg 2007, p. 45). Since both, in their present forms, were developed in an era of cheap, abundant energy, this conclusion seems reasonable. Both corporations and nation-states espouse perpetual, robust economic growth that is spurred by consumption of material goods. Speth (2008, p. 47) remarks: "When one wants to kill a proposal for government action, the most effective argument is that it will hurt the economy, exactly what President Bush said when he rejected the international climate treaty's Kyoto Protocol early in his administration." Growth is often the metric first mentioned for everything from churches to housing starts. The diseconomies of growth are rarely mentioned. However, the old story of no limits to growth (i.e., limitless substitution of resources will be available as the current resources are depleted) is beginning to fray around the edges, particularly in the areas of energy, food, water, and arable land. Speth (2008, part 1, section 2) feels that modern capitalism and the corporations that purport to represent limitless growth must change markedly (Speth, part 2, section 8). If either corporations or sovereign nations survive, they will be vastly different than they now are.

## Population and Energy

At the time of the Agricultural Revolution, the estimated global population of *Homo sapiens* was 5 to 10 million (Ehrlich and Ehrlich 2008, p. 143). At the time of Christ, the global population was probably 250 to 350 million. By AD 1650, it had reached one-half billion, and by 1850 had doubled to 1 billion. In 2008, the global population is 6.7 billion and still growing at the rate of 215,000 individuals per day.

However, this nearly 7-billion mark was reached while petroleum was cheap and demand did not exceed supply. Grains, such as wheat and corn, are grown on vast tracts of land by massive machines that prepare the land and harvest the crops. Fertilizer is also obtained from petroleum, which is also used to process the grain, package it, and transport it to markets all over the world. As the cost of a barrel of oil rises, so will the price of grain. Finally, in the United States and some other countries, grain (e.g., corn) is transformed into ethanol for automotive fuel. This competition for finite supplies of grain also increases the price. The world grain reserve in June 2008 was about a 50-day global supply, so a poor harvest in 2008 would create a major crisis. The arable land in 2008 was 0.35 hectares per capita, so an exponentially growing population is a serious problem. As if these factors were not enough, a 30% ecological overshoot exists (using resources faster than they are being regenerated), which means humankind is depleting the biosphere when it should be maintaining its integrity.

Astonishingly, population is rarely discussed, even though human population growth obviously cannot continue on a finite planet. Since climate change is already adversely affecting agricultural productivity, a meaningful discussion is long overdue. For example, is humankind's goal to amass the maximum number of people the planet can hold at a subsistence level or should the growth rate be reduced to within the planet's carrying capacity so that individuals can lead a quality life? China is the leading sovereign nation in terms of overt population control, but, in other sovereign nations where birth control methods are available at prices the citizens can afford, the birth rate has fallen to replacement levels or less. However, even in these countries, legal and illegal immigration have offset the benefits of a reduced birth rate.

## Taboos

Many people simply refuse to discuss or even think about certain problems. At present in the United States, discussions are not welcome on such problems as population growth, a finite global supply of oil, the consequences of markedly exceeding Earth's carrying capacity for humans, reducing anthropogenic greenhouse gas emissions, the urgent need for greatly expanded public transportation, the end of the automobile era, and the loss of individual liberty and privacy.

*The American Heritage Dictionary* defines the word *taboo* as "a prohibition excluding something from use, approach, or mention because of its sacred and inviolable nature." Hardin (1996, p. viii) remarks:

*Observing other cultures we note that taboo can affect objects, actions, words, or thoughts. In our own culture the concept of the taboo may not be much needed for the first two classes. Few if any objects are taboo to touch in our society, and the forbidding of actions is adequately handled, for the most part, by legislation. . . . The third class of tabooed things – words – brings us face to face with a paradox. If we refuse to discuss a subject, how can we inform the unknowing what it is that is sacred? Even to delineate the sacred in words is to violate the taboo. A word-taboo is a sort of Chinese egg. Inside is the primary taboo, surrounding a thing that must not be discussed; around this is the secondary taboo, a taboo against even acknowledging the existence of the primary taboo.*

Most important to this discussion is Hardin's (1996, p. x) statement: "Science, to be successful, must be open. As soon as a barrier to discussion becomes evident, we know that scientific investigation has been stopped in that direction." Hardin (1996, p. xiii) further notes: "A taboo on words that is held inviolate for a long time becomes a taboo on thinking itself. (How can we think of things for which we hear no names?)"

As a young scientist, I observed the outrage provoked by Rachel Carson's *Silent Spring*. How dare Miss Carson (not Dr. Carson) suggest that chemicals might harm living things when Drs. X, Y, and Z stated that they did not! Humankind had the deep emotions of those in the thrall of a taboo. Her book is now a classic of environmental literature. Following are the major taboos that scientists have broken during my lifetime.

- (1) Scopes Trial on Evolution 1925
- (2) Peak Oil (M. King Hubbard) 1956
- (3) Pesticides (Rachel Carson) 1962

- (4) Population Bomb (Paul Ehrlich) 1968
- (5) Diseconomies of Economic Growth (Kenneth Boulding) now underway
- (6) Global Warming (James Hansen) now underway

Hardin (1996, p. ix) offers some sage advice: “. . . the stalker of taboos, if he is to survive, must learn from the predatory animals, must adopt their tactics: long periods of quietness, a long profile, protective coloration, and the diversion of the quarry’s attention to other matters until the propitious moment.”

I witnessed my mentor Ruth Patrick transcend both the taboo against women in science and “applied” research. She organized a team in 1948 to study the effects of pollution on aquatic communities (i.e., applied research). Few women scientists existed at that time and even fewer were studying pollutant effects on aquatic biota. Her science was noteworthy, and the applied research had meritorious theoretical value. Patrick stuck to the science and published in peer-reviewed professional journals and, decades later, was showered with honors and awards. She celebrated her 100<sup>th</sup> birthday in November 2007, and she still goes to her office in the Academy of Natural Sciences weekdays.

I have great admiration for the many scientists who have surmounted many taboos. Arguably, the “Stalker of Taboos Award” for the 21<sup>st</sup> century should be given to James Hansen, a scientist who has been with the US National Aeronautics and Space Administration for many years. His career-long development of computerized climate models has been critical to demonstrating human-induced climate change. Despite formidable obstacles placed in his path by government bureaucrats and political ideologists, Hansen prevailed. On 23 June 1988, Hansen told a US Senate committee that he was 99% certain that the year’s record temperatures were not the result of natural variation (Block 2008), and the battle of science vs political ideology was underway. In 1986, two separate polls found that most Americans (55%) still had not heard of the greenhouse effect (Block 2008). At present, thanks to former US Vice-President Al Gore, the Intergovernmental Panel on Climate Change reports, and the research of literally thousands of scientists, discussions of modern technology’s role in greenhouse gases adverse climate effects are no longer taboo. Doing something significant about the greenhouse effect is another matter since some political leaders continue to state that remedial measures might have adverse effects upon economic growth.

### **The Myth that Human Technology can Conform Nature to Humankind’s Needs**

In June 2008, catastrophic dam failures were occurring up and down the Mississippi watershed in the “Flood of 2008” (Nienaber 2008). Of course, Mother Nature is “responsible” for the rain. However, low lying areas adjacent to rivers are called flood plains for a reason – they are periodically flooded. Nevertheless, developers build houses on them and citizens buy the houses, confident that human technology (e.g., dams and levees) can control adverse effects of high volumes of water. Not so. In Lake Delton, Wisconsin, a US Army Corps of Engineers embankment failed, and a 267-acre lake that was the centerpiece of a recreational area was emptied. The torrent of water destroyed homes and carved a new channel into the Wisconsin River (Nienaber 2008). In Cedar Falls, Iowa, spokeswoman Susan Staudt stated during torrential rains there: “Quite frankly, the only forces keeping the water from breaching the barriers are the thousands of volunteers who are sandbagging” (Nienaber 2008).

Of course, flooding has damaged crops that are now lost, with no time for replanting (Saulneg 2008). Levees have already been breached, which increases damage in some areas and lessens damage in other areas downstream (Davey and Einhorn 2008). In China, the recent, massive (7.91) earthquake has flooded 9,000 square miles, which includes a major sugar producing area (Ruwitch 2008). Of course, floods have occurred in the past, but not in the present circumstances where 215,000 more people need to be fed each day. The entrenched theory in India has been that the hotter it gets, the better the chances of a monsoon. However, this year, the north has been cooler by almost 1.5°C. Yet, only 12 days, instead of 30, were needed for the monsoon to cover most of India (Bagla 2008). Is this situation a consequence of climate change?

Kamyar Enshayan, director of an environmental center at the University of Northern Iowa, notes that the “natural” disaster of flooding is not really all that natural (Achenbach 2008) since “. . . heavy rains fell on a landscape radically reengineered by humans. Plowed fields have replaced tallgrass prairies. Fields have been meticulously drained with underground pipes. Streams and creeks have been straightened. Most of the wetlands are gone. Flood plains have been filled and developed.” Now crops are threatened when the food supply is precarious and exponential population growth is still occurring. Amy Goodman (2008) quotes Joseph Romm, a senior fellow at the Center for American Progress, about the disconnect (between the cause of extreme weather and global heating) and the flooded agricultural lands: “Part of the reason is that people who write about global warming for most newspapers and TV are not the same people as those who tend to cover weather. In general, the media is covering this as all sorts of unconnected events, just regular weather maybe gone a little wacky.” However, other dots should be connected (e.g., Joshi 2008).

## Connecting Ecology and Economics

Jeffrey Sachs remarks: “. . . simple, cheap, concentrated power lies at the heart of our modern economies. Every action of a modern life burns fossil fuel; viewed in one way, modern Western human beings are flesh-colored devices for combusting coal and gas and oil” (McKibben 2007, p. 15).

However, fossil fuels are running out, but the carbon dioxide resulting from burning them will remain in the global atmosphere for hundreds of years and the ecological effects of global heating will last for hundreds of years more. In the United States, this situation does not yet seem to be a matter of significant public concern – neither does the huge federal and personal debt. Of course, one should appreciate the present, but the present can be enjoyed without having a cavalier attitude toward the future. Even at age 85, I find the trend lines on energy, population, greenhouse gas emissions, etc. disturbing since they are indicators of the future if humankind continues “business as usual.” The current flooding in Iowa, Illinois, and Missouri illustrate what happens when past events are ignored:

*After the last devastating flood in the Midwest about 15 years ago, a committee of experts commissioned by the Clinton administration issued a 272-page report that recommended a more uniform approach to managing rising water along the Mississippi River and its tributaries, including giving the principal responsibility for many of the levees to the US Army Corps of Engineers . . . the committee chairman, Gerald E. Galloway, Jr., a former brigadier general in the Corps of Engineers, stated that few broad changes were made once the floodwaters of 1993 receded and were forgotten (Davey 2008).*

Similarly, “India’s supply of arable land is second only to that of the United States, its economy is one of the fastest growing in the world, and its industrial innovation is legendary. But, when it comes to agriculture, its output lags far behind potential. For some staples, India must turn to already stretched international markets, exacerbating a global food crisis” (Sengupta 2008). In contrast, China has one-third of the world’s farmers, but one-fifteenth of the world’s arable land; in many places, the average holding is less than one-sixth of an acre (McKibben 2007, p. 39).

## Ecological Upsetters

In 1968, I had the privilege of sitting on the right side of economist Kenneth E. Boulding (all authors were arranged in alphabetical order around a huge, circular table) for a week-long conference on the ecological aspects of international development (Favar and Milton 1972). During the conference, Boulding wrote the now classic “Ballad of Ecological Awareness,” which served as the conference summary since it effectively summarized the defining message of each discussion. The four lines most appropriate for this commentary follow.

*One principle that is an ecological upsetter  
Is that if anything is good, then more of it is better,  
And this misunderstanding sets us very, very wrong,  
For no relation in the world is linear for long.*

The current high energy, resource depleting, “throw away” society has resulted in a 30+% ecological overshoot and has damaged the integrity of the biospheric life support system. Arguably, worst of all, society has not been concerned about exponential population growth, which is coupled with vastly increased consumption of material goods. Humankind has markedly violated carrying capacity and numerous other natural laws. However, some economists believe resources are not limiting – for example: “Our supplies of natural resources are not finite in any economic sense. Nor does past experience give reason to expect natural resources to become more scarce. Rather, if history is any guide, natural resources will progressively become less costly, hence less scarce, and will constitute a smaller proportion of our expenses in future years” (Economist Julian Simon, <http://www.worldofquotes.com/author/Julian-Simon/1/index/html>).

In contrast, Liebig’s Law of the Minimum states: “Growth is controlled not by the total of resources available but by the scarcest resource (limiting factor).” Liebig’s Law has been extended to biological populations and is commonly used in ecosystem models: growth only occurs at the rate permitted by the most limiting factor. Meadows et al. (1972, 2004) give many examples of limiting factors.

In 2008, humankind is encountering an array of limits (i.e., scarce resources) that seem to be occurring all at once: (1) arable land, (2) potable water, (3) expensive oil, (4) home values, (5) air fares, (6) college tuition, (7) health care, (8) food, (9) leisure time. Fram and Putman (2008) summarize the sense of helplessness in the United States today: “The can-do, bootstrap approach embedded in the American psyche is under assault.

Eroding it is a dour powerlessness that is chipping away at the country's sturdy conviction that destiny can be commanded with sheer courage and perseverance." Charles Truxal, a retired corporate manager, shares this grim view of the future: "People are thinking things are going to get better, and they haven't been. And then you go hide in your basement because tornadoes are coming through. If you think about things, you have very little power to make it change" (quoted in Fram and Putman 2008).

### **The Biospheric Life Support System: Luxury or Necessity?**

The United States is now experiencing a severe recession that could turn into a depression. Gas prices are up dramatically, the housing market is in decline, and food prices are soaring. Simultaneously, the integrity of the biospheric life support system, upon which humankind is utterly dependent, is threatened by global heating, species impoverishment, and ecological overshoot. However, the dominant paradigm is economic growth, and protecting the environment might threaten the economy; consequently, the environment is perceived as an unaffordable luxury during an economic downturn. Since oil prices have risen tenfold in the last year, the economy is the highest priority for American citizens. Tar sands, which produce three times more carbon dioxide than crude oil, are being "mined" to increase the transportation fuel supply. This action is suicidal since society is probably approaching another global tipping point. World-class climatologist James Hansen testified in June 2008 before the US Congress that atmospheric carbon dioxide should be reduced from the present 385 ppm to, at most, 350 ppm. Lowering gasoline prices and increasing consumption, which increases greenhouse gas emissions, is simply insane. Paul Ehrlich (personal communication) states the matter succinctly: ". . . the economy is a wholly-owned subsidiary of the environment." In short, if the biospheric life support system is altered so that it is no longer favorable to humans, they will become extinct and the human economy will go with them.

Embedded in this bad news is some good news. The economic downturn, including increased gasoline prices, has resulted in less travel, preference for fuel efficient cars, increased use of public transportation, fewer restaurant meals (less driving), more home videos (fewer trips to movie theaters), and more domestic vacations. All these reduce greenhouse gas emissions. P. S. Goodman (2008) reports that the economics of American suburban life are under assault as skyrocketing energy prices inflate the costs of reaching, heating, and cooling homes on the distant edges of metropolitan areas: "Living closer in, in a smaller space, where you don't have that commute . . . It's definitely something we talk about. Before it was 'we spend too much time driving.' Now, it's 'we spend too much time and money driving'" (P. S. Goodman 2008). Housing prices are dropping, so some experts feel the shift will be gradual. It probably depends on how rapidly energy prices increase. In some small, rural towns, the situation is reversed. Poor people cannot afford to live in town, so they commute – some as far as 45 miles each way. Many carpooled, even before gas prices increased dramatically. Food prices and shopping are also a financial burden. Suddenly, the well established housing lifestyle is under assault. Doing the "right thing" (lowering greenhouse gas emissions) for the "wrong reasons" (saving money rather than protecting humankind's life support system) is now becoming increasingly common in the United States.

### **Denial, Selective Refusal/Disbelief**

In December 2007, the White House refused to accept the Environmental Protection Agency's (EPA) conclusion that greenhouse gases are pollutants that must be controlled, informing agency officials that an e-mail message containing a certain document would not be opened (Barringer 2008). The document, which ended up in e-mail limbo, without official status, was the EPA's answer to a 2007 US Supreme Court ruling that required it to determine whether greenhouse gases represent a danger to health or the environment. Although illegal immigration, ethnic violence, humanitarian crises, and national security issues will worsen during the next two decades because of global heating, according to US intelligence agencies (Miller 2008), just 49% of Republicans say Earth is warming as of April 2008 (Pew Research Center 2008). In April 2008, 84% of Democrats and 75% of Independents say Earth is warming. This is a disturbing situation with Earth in imminent peril.

### **Is This Humankind's Last Chance?**

Nothing in this world is absolutely certain – politicians may fail to live up to their promises, the use of dozens or more nuclear weapons may put enough energy reflecting particles in the atmosphere and cause a nuclear winter, or stochastic events beyond any imagination may occur and alter the global climate drastically. Still, if humans continue their present greenhouse gas emissions, a high probability exists that the global temperature will rise to 3° above the norm of the 20<sup>th</sup> century. Even reading Mark Lynas' prediction of a 3°C rise is enough to appall any civilized person. Lynas (2008, p. 21) uses a temperature scale based on the Intergovernmental Panel on Climate Change (IPCC) landmark 1.4°C to 5.8°C (2.6° to 10.4°F), published in its 2001 third Assessment Report, which provides predictions up to 6°C. A super volcano would probably create colder conditions as well. On the other hand, if the positive feedback loops, particularly frozen methane in the

ocean depths or in permafrost is converted to gas by warming, temperatures could rise very quickly indeed. The announcement has been made that the Arctic might be ice free by summer 2008 (e.g., Connor 2008), and, if not this summer, then some summer in the near future. This event has major ecological significance, but few non-scientists seemed to care. Of course, those interested in drilling for oil are overjoyed. Politicians scrambled to ensure their nation received its fair share – or better yet, a bit more. Bad news for polar bears, but then humankind has to make some sacrifice to prolong the cheap, high energy “party.”

## Conclusions

In the 21<sup>st</sup> century, climate change is occurring at a frightening pace and yet no substantive effort is being made to reduce greenhouse gas emissions so that the atmospheric carbon dioxide concentration is lowered to 350 ppm at the most. Politicians talk of reducing greenhouse gas emissions at future dates (e.g., 2025 or 2050) when they should be reduced now to avoid a variety of klimakatastrophes. Humankind needs a Winston Church to say: “I have nothing to offer but blood, toil, tears, and sweat. We have before us an ordeal of the most grievous kind. We have before us many, many months of struggle and suffering.” I believe the general public, and perhaps even the politicians and corporations, would respond to this honesty about the climate crisis as the British public did during World War II. However, now, as then, the response must be immediate.

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