Asian J. Exp. Sci., Vol. 22, No. 3, 2008; 423-434 **Commentary**

Science and Values for a Finite Planet

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Abstract : Exponential population growth on a finite planet means less resources per capita, and humankind is dependent upon the resources of the biospheric life support system for survival. However, humankind has acted, in the past, as if it does not recognize either of these obvious realities, but recent events make it more likely that both concepts will be accepted. Although scientific research is carried out in a variety of sources, society places the primary responsibility for this important activity upon its universities. Scientific results must not be suppressed or altered because they are not congruent with political ideology or articles of religious faith. Similarly, value judgments should be left to society. When scientific evidence and analysis are used to make a value judgment, the general public must be acquainted with the scientific process – scientific judgments are based on the preponderance of evidence. The news media are doing a disservice to the public if they describe a "balanced" coverage with a few doubters of a concept on one "side" and thousands of credentialed scientists on the other. This type of coverage is being perpetuated frequently in global climate change reporting when the future of civilization is at stake.

Key words : Scientific process, Value judgments, News "balance," Ethical/moral judgments, Carrying capacity, Overpopulation, Biospheric life support system, Censorship.

We do not act rightly because we have virtue or excellence, but we rather have those because we have acted rightly.

Aristotle, Philosopher and Scientist

Corporation, n., An ingenious device for obtaining profit without individual responsibility.

Ambrose Bierce, Columnist

All that is necessary for the triumph of evil is that good men do nothing.

Edmund Burke, Philosopher

It has yet to be proven that intelligence has any survival value.

Arthur C. Clarke, Writer

The mind of the superior man is conversant with righteousness; the mind of the mean man is conversant with gain.

Confucius, Philosopher

Management is doing things right; leadership is doing the right things.

Peter F. Drucker, Management

Science is simply common sense at its best that is, rigidly accurate in observation, and merciless to fallacy in logic.

Thomas Henry Huxley, Biologist

[Science is] the knowledge of consequences, and dependence of one fact upon another.

Thomas Hobbes, Philosopher

There is no adequate defense, except stupidity, against the impact of a new idea.

Percy Williams Bridgman, Physicist

The hypotheses we accept ought to explain phenomena which we have observed. But they ought to do more than this: our hypotheses ought to foretell *phenomena which have not yet been observed.*

William Whewell, Mathematician/ Philosopher

US President Bush's intervention in a US Environmental Protection Agency's (EPA) tightening of the amount of smog-inducing pollutants that could be released into the air from

84 parts per billion (ppb) to 75 ppb has some environmental activists questioning whether politics trumped science (Washington Post, 2008). This concern about President Bush seems counterintuitive since the actual reduction was 9 ppb released into the ozone layer. However, the Clean Air Act regulates the ozone on two levels. The primary standard seeks to protect public health while the secondary one guards the public welfare or the overall environment. A unanimous US Supreme Court ruled in 2001 that, in setting any new limit, only science can be considered, not the costs of implementation (Washington Post, 2008). Environmentalists are upset because they feel the President usurped EPA Administrator Stephen L. Johnson's authority under the Clean Air Act to make the final determination. In addition, environmentalists are upset because EPA ignored a scientific advisory panel's recommendation of limits between 60 and 70 ppb for public health. The difference of a few ppb could prevent several thousand premature deaths (Editorial, 2008a). In this example, President Bush is ignoring both scientists and the US Supreme Court (Editorial, 2008b).

This situation is a recent example, but not a unique one where science is concerned. Itano (2008) reports on the European Union foreign-policy report by Chief Javier Solana and Benita Ferrero-Waldner, the European commissioner for external relations. The report states that climate change is a "threat multiplier" which "intensifies existing trends, tensions, and instability." This situation means a major, additional time expenditure on scientists whose work load is already heavy. Another problem of unknown magnitude, but which is already a matter of concern, is the case of eight scientists (cited by the US Congressional [House] Energy and Commerce Committee) who were consultants or members of EPA science advisory panels assessing the human health effects of toxic chemicals while enjoying research support from the chemical industry on the same chemicals they were examining (Hebert, 2008). At the very least, such circumstances cast doubt on the integrity of the reports the committee produces. The worst possible case might involve damage to human health. Maintaining scientific integrity takes time and effort, but, without it, scientific evidence and judgment will not be highly regarded.

Where Does New Scientific Information Come From?

Although scientific information comes from a variety of sources, society places primary responsibility for generating it on its universities. I obtained my first academic degree from Swarthmore College, where the primary faculty responsibility is teaching undergraduates. At the time I attended (1946-1947), most faculty also produced books and articles in peer-reviewed journals. The education at Swarthmore prepared me for a research career. In the United States, teaching is the primary faculty function in thousands of colleges: 629 public and 1,845 private 4-year institutions, and 1,070 public and 5,966 private 2-year institutions. These colleges offer plenty of opportunities for faculty and students who wish the primary focus of their institutions to be on teaching. In a university, faculty must teach courses, supervise graduate students, advise students, serve on committees, keep up with the professional literature, serve on national and international professional panels, give lectures at professional meetings and at other academic institutions, review articles for professional journals, write grant proposals, and participate in university functions. For example, each grant proposal from my Center for Environmental Studies took up to 142 hours of staff time, of which at least 60 hours were the time of the lead investigator. Many graduate students are funded by research grants, which is the basis for a close working relationship with the major professor.

Tracking scientific productivity and competence is another matter. Merely

counting the number of universities will not be especially productive. Cutting-edge research is carried out predominantly by a relatively small number of institutions, as evidenced by the institutional distribution of members of the US National Academy of Sciences. However, world-class hypotheses can be developed in unexpected places. Lovelock (1988, pp. x, xiv) found that he had difficulty carrying out full-time research on "Earth as a living planet" while being a university scientist, so he worked at home (a modified water mill on River Carey) and supported himself and his family by whatever means came to hand. However, Lovelock (1988, p. x) cautions:

> We are, quite literally, in a new world, a much more peculiar place than it seemed a few centuries back, harder to make sense of, riskier to speculate about, and alive with information which is becoming more accessible and bewildering at the same time . It sometimes seems that there is not just more to be learned, there is everything to be learned.

This prophetic statement was published approximately two decades ago, and time has merely given it more meaning.

Preponderance of Evidence

Former US Vice-President Gore, a leader in the effort to inform the world about global climate change, has frequently remarked that the United States should be the leader in the effort to markedly reduce greenhouse gas emissions. However, instead, the United States has refused to join efforts to set quantitative goals for greenhouse gas emission reductions. Why is that? Multiple reasons could be listed, but one often overlooked in the approach to the problem by scientists, politicians, and the news media is a well funded misinformation campaign, leaving the general public unable to realize the seriousness of the imminent peril of greenhouse gas emissions.

Scientists base their judgments on the preponderance of evidence as well as the quality of the evidence – for example, has the research been published in peer-reviewed scientific journals? Science is based on probabilistic determinations based upon confirmed or validated evidence. Scientists accept some uncertainty as inevitable, but they recognize ways to reduce uncertainty and increase confidence in the data. Scientists also accept that the biosphere is dynamic and should be monitored and studied continuously. Finally, one responsibility of scientists is to report on any error they find in their own research or that of others. "Loyalty" is not attached to a hypothesis or concept, but a firm belief in the scientific process as a means of generating new, reliable information and correcting errors or deficiencies.

A substantial number of politicians are lawyers. The United States has approximately 950,000 to over 1 million lawyers – 70% of the world's lawyers, although the United States has only 5% of the world's population. Lin Yutan, a Chinese philosopher, once stated: "Where there are too many lawyers, there can be no justice." In the US Congress, the House of Representatives has 435 members and the Senate 100, for a total of 535. In the 109th Congress, 228 members had law degrees and 217 members noted their former occupation as law, for a total of 445. Only 24 scientists, even when the term is broadly interpreted, were identified. This number includes medical doctors and at least one veterinarian (Vallicella, 2007). Of the over 70,000 practicing lawyers in Washington, DC, alone, a large number of them are involved in some form of advocacy (lobbying) (Oliphant, 2008). This dominance is important because, in law, one selects or is assigned a point of view and then gathers evidence to support it (defense) or tear it down (prosecution). Preponderance of evidence plays a role in a lawyer's practice, but not in the same way it does in science.

The news media virtually ignores preponderance of evidence in favor of "balance." In the global heating debate, literally thousands of scientists (e.g., Intergovernmental Panel on Climate Change) support the concept that greenhouse gas emissions from anthropogenic sources are a major factor in global climate change; only a few deniers (some with no scientific credentials) are on the other "side." In addition, the US National Academy of Sciences and its equivalents in other developed countries support the hypothesis that climate change is markedly influenced by greenhouse gas emissions. In order to act effectively to curb global climate change, human society needs to better understand these differences in perspective.

Values

Scientists make value judgments in determining the types of research to carry out and in establishing research priorities. However, these choices are not ethical/moral judgments. Most often, when people use the term *values*, they refer to ethical/moral values. For example, the United States is presently talking about reducing dependence upon foreign oil. One of the proposed solutions is turning corn into ethanol for fuel, which immediately sent the price of corn soaring. Scientists provided evidence on the energy input/output ratio for the production of ethanol for fuel (which was not favorable), but scientists could and should not comment on the ethical/moral consequences of sending food prices even higher so that poor Mexicans could no longer afford tortillas, which are made from corn. However, scientists could and did provide evidence on the huge amount of water (for which demand is increasing) needed to produce corn and the rate of depletion of underground aquifers, where these are used for irrigation in the production of corn (e.g., Cox, 2008a).

The Ogallala aquifer, a major source of irrigation water in the High Plains, is being mined at a rate that, in some areas, will drain it in the near future. The Ogallala was trapped underneath the High Plains at the time of the last ice age around 11,000 years or more ago (Cox, 2008a). As a consequence, natural recharge of water in this aquifer in any time frame meaningful to humans is unlikely. Whether to mine this precious water to cope with an energy emergency that resulted from poor planning and management and an unwillingness to conserve becomes an ethical/moral decision.

Some illustrative value judgments that require scientific information to resolve effectively follow.

(1) Humankind has exceeded Earth's carrying capacity substantially. Evidence available from ecological footprint size and ecological overshoot confirm this situation. However, science cannot and should not tell human society how to address this problem. Science can identify various approaches for halting ecological overshoot, such as reducing population size, reducing consumption, and allocating resources more equitably; however, human society must make an ethical/moral decision on what should be done, or Mother Nature will reduce population size by death and disease.

(2) The biospheric life support system has maintained conditions favorable to humans for 2 million years, but it is being damaged by human activities. Humankind can alter its lifestyle to protect the integrity of the biospheric life support system or it can continue its present practices. The latter choice will probably result in disequilibrium in the biospheric life support system from which a new equilibrium will probably emerge, as past extinctions have demonstrated. The new equilibrium condition may or may not be favorable to humans. As usual, the default position, doing nothing and letting nature take its course, is risky; however, doing something will require major "sacrifices" and adjustments in lifestyle and may not prove

effective if climate change has passed a major ecological tipping point. The choice is clearly an ethical/moral value judgment, but time is short to ponder the choice.

(3) Exponential economic growth has produced many deleterious environmental effects (e.g., excessive greenhouse gas emissions), but it remains a primary goal for most societies (e.g., China, United States, India). Is a more sustainable lifestyle possible and desirable? If so, why has humankind failed to make the ethical/moral decision to change?

(4) Humankind shares the planet with 30+ million other life forms. However, humans treat them as commodities (i.e., resources) and do not hesitate to take their habitat and convert it to meet human "needs." Humans also take food from a variety of other life forms to meet humans "needs" – for example, intensive harvesting of tiny crustaceans (krill) for fish food and omega 3 (nutrient supplement) places entire ecosystems at risk (Jowit, 2008). Science can document the harm and risk to natural systems, but it cannot tell humankind to protect the charismatic species such as whales, seals, albatrosses, and petrels that are already endangered by krill harvesting. Ironically, krill are also believed to be important in removing the greenhouse gas carbon dioxide by eating carbon-rich food near the surface and excreting it when they sink to lower, colder water to escape predators (Jowit, 2008).

(5) Yellowstone National Park is home to the American plains bison (buffalo), which is one of only two genetically pure herds owned by the federal government. For thousands of years, bison migrated freely in huge herds over the Great Plains. However, with heavy snows now covering the parks vast grasslands, bison have been leaving Yellowstone in search of food at lower elevations. In addition, 1,195 of the migrating animals (about one-fourth of the park's population) have been killed by hunters or have been rounded up and sent to slaughterhouses by park employees. This large-scale killing of bison, referred to as culling, is expected to continue through April 2008. Ranchers near Yellowstone fear some bison might carry brucellosis, a disease that can be passed on to cattle. Brucellosis can also be transmitted by elk, which also inhabit Yellowstone. An agreement to obtain land along Yellowstone River that would allow the bison to cross to a publicly owned forest north of the park has stalled because the funds for the land purchase have not been allocated by the US Congress. The State of Montana and conservationists are committed to raising $1.3 million toward the $3 million or so it would cost to lease the land for 30 years. Representative (US Congress) Denny Rehberg (Rep., Montana) was blamed by Montana Governor Brian Schweitzer (Dem., Montana) for leading the opposition, in summer 2007, to a $1.5-million US Congressional appropriation that would have fulfilled the federal obligation. The standoff was exacerbated by the detection in 2007 of brucellosis in several cattle elsewhere in Montana. Experts believe the disease was transmitted by elk, not bison (Robbins, 2008).

The effort to preserve a genetically pure population of bison, an American icon, has been blocked by commercial interests that have triumphed; over 1,000 bison have been slaughtered, with more to come. The value question is: do the bison have a right to a tiny percentage of the habitat they once occupied when the North American Plains Indians were the dominant human culture?

(6) Although autoimmune diseases remain underrecognized and underaddressed, the number of patients afflicted with these illnesses has been steadily growing (Nakazawa, 2008). In autoimmune disease, the immune system itself leads the attack, mistaking the body's tissue for an invader and turning on the body itself. Acquired immune deficiency syndrome (AIDS) is caused by a virus that attacks the immune system and destroys it. Autoimmune diseases are the eighth leading cause of death

among women, shortening the average patient's lifespan by 15 years. Nakazawa (2008) notes that, while 1 in 69 women below the age of 50 will be diagnosed with breast cancer according to estimates, as many as 1 in 9 women of childbearing age will be diagnosed with an autoimmune illness, which strikes three times as many women as men – and most often strikes patients in their prime. According to the National Institutes of Health, autoimmune disease affects far more patients than the 9 million American citizens who have cancer and the 16 million with coronary disease (Nakazawa, 2008).

This issue is included here for a particular purpose. In this instance, the research on autoimmune diseases is still in the early stages and uncertainty is high. However, people in their prime are suffering grievously and their contributions to society are markedly reduced as a consequence.

This situation is particularly challenging since scientists from the US National Institutes of Health have announced, after studying 300,000 death certificates in 26 US states over a 14-year period, that people who worked with pesticides; textiles; hand painting; solvents, such as benzene; and asbestos and other compounds were significantly more likely to die from an autoimmune disease than people who were not exposed (Nakazawa, 2008). Some people who are exposed to these autogens do not come down with a disease because each person has a unique genetic composition and is exposed, in their daily lives, to myriad combinations and levels of autogens. Both genes and exposure level play a role.

However, although science can improve the understanding of the autoimmune epidemic, many people are suffering now. Society has produced the chemicals, authorized their production, and used them in various ways. Some illustrative value judgments on the issue of the autoimmune epidemic follow.

- How much money should be devoted to generating more scientific information?
- How much responsibility should society accept for caring for the afflicted?
- Should government regulate exposure to chemicals associated with the autoimmune epidemic?
- What role should the government play in informing both health care professionals and the general public about the epidemic and reducing exposure to potentially hazardous chemicals causing the epidemic?
- What responsibility should manufacturers of the chemicals causing the epidemic accept or be assigned by law?

Political Ideology vs Science

Regrettably, political ideologues often feel threatened by science, especially with such concepts as economic growth. Goodman (2008) leads a discussion about an ongoing controversy when Dr. James Hansen, widely regarded as one of the world's leading climate change scientists, testified in 1988 to a Senate committee for the US Congress. For one-quarter of a century, Hansen has headed the Goddard Institute for Space Studies, the National Aeronautic and Space Administration's (NASA) premiere climate research center. John Passacantando remarks during the discussion: "This government, at the behest of its oil company contributors, has been told not to put out information about global warming, not to allow the scientists to talk about their expertise with the press, about the connection between global warming and hurricanes." In the discussion, Tim Flannery remarked: "Can you imagine what it would be like for one of the world's leading scientists, who is revered by everyone, to have this pipsqueak who lied about his credentials

controlling what he (Hansen) tells the public? Just appalling."

The basic point is that, in order for humankind to survive this imminent peril (Hansen's words), scientists must have their evidence presented to the public without censorship. The news media personnel who participate in this effort must be objective, scientifically literate, investigative reporters and not represent the ideology of lobbyists, advertisers, or political affiliations of their news organizations (Bowen, 2008).

A new legal battle is on the horizon that involves both science and values. Inupiat villagers of Kivalina, Alaska, are involved in a lawsuit alleging that energy companies conspired to create a false sense of doubt about the effects of global heating (Schwartz, 2008). In February 2008, Kivalinan citizens filed a federal lawsuit against 24 oil, gas, and electric companies to hold them fiscally responsible for the carbon emissions that contribute to global heating. The suit follows a growing number of cases that are trying to tackle climate change through the legal system by targeting business or government policies (Schwartz, 2008). The plaintiffs argue that energy companies, including Exxon-Mobil, Chevron, and Duke Energy have created a public nuisance (Schwartz, 2008). Judges have recently thrown out three other public nuisance cases against corporations on the grounds that global heating is a political question best addressed by legislatures. However, the cases are all being appealed. Schwartz (2008) notes other lawsuits have forced policymakers to consider the impact of global heating in their city planning and corporate expansions. However, the most intriguing element is that the Kivalina case models itself after the lawsuits against the big tobacco companies in the 1990s, which held cigarette manufacturers liable for hiding the hazards of tobacco from the public and the spread of misinformation through industry-paid front groups. The suit cites internal documents from the Information Council on the Environment – formed by the Southern Company, a major coal utility, and other coal interests – showing that the Council's goal was to "reposition global warming as a theory." One of the organizations participating in the misinformation campaign was the Advancement for Sound Science Coalition, an organization started by Philip Morris to do the same for the link between tobacco and cancer (Schwartz, 2008).

This case will be another challenge to science and scientists, since the main purpose of the energy companies is to cast doubt on scientific integrity. Regrettably, the US news media all too often treat these lawsuits on environmental issues as entertainment, rather than a threat to human society. In fact, the controversies are contests in which corporations with financial resources of many billions of dollars are pitted against thousands of scientists with comparatively modest financial resources. In fact, many scientists volunteer their time to such organizations as the US National Research Council (NRC) (the operating arm of the US National Academies of Science and Engineering), although their travel, meals, and lodging expenses are paid. Moreover, most scientists who serve on committees for the NRC are expected to maintain their teaching, advising, and other professional activities at their home institution. In fact, if any activity suffers, it is probably the scientist's research; consequently, the climate change deniers have had a deleterious effect by reducing the gathering of evidence on climate change. In contrast, energy companies and other business interests have launched a nationwide campaign to undermine climate change legislation pending in the US Congress, stating that the legislation would cost millions of jobs, drive gasoline prices sharply higher, and suck thousands of dollars from household incomes (Brown, 2008).

Antibiotic Resistance

Both the science and the development of antibiotic resistance, as well as ethical/moral values, would benefit from a free and open public debate. Science (public health experts) has been warning for over a decade that a "post antibiotic era" is rapidly approaching – antibiotic therapy will no longer be effective – and the situation is deteriorating with ever increasing speed (Grundmann, 2008). Antibiotic resistance is when an antibiotic has lost its ability to effectively control or kill bacterial growth. The targeted bacteria adapt by natural selection to become resistant and continue to multiply despite the presence of the antibiotic. Hepeng (2008) quotes Xiao Yonghong, Deputy Director of the Institute of Clinical Pharmacology at Peking University in Beijing, China, as stating that resistant bacteria cause 60-70% of the infections from common bacteria such as *Escherichia coli* that cause intestinal infection and *Pneumococcus* that causes pneumonia. The major driving force behind the emergence and spread of antibiotic-resistant pathogens is the rapid rise of antibiotic consumption – the most direct contributor to resistance is the overuse of antibiotics. Xiao estimates that 30% of drugs sold in Chinese hospitals are antibiotics, while in the developed world, the proportion is only 10%.

However, Bhutta and Ali (2008) state that reducing antibiotic use is not enough to curb the rise of resistance in the developing world. They make the very important point that resistance can also be transferred between different disease-causing bacteria, with deadly consequences for health systems in both developed and developing countries. Bhutta and Ali (2008) make two additional important points. (1) Poverty and inequity are major drivers of antimicrobial resistance. In developing countries, they are linked to inadequate access to effective drugs, unregulated dispensing by unqualified staff, and truncated therapy for reasons of cost. (2) Substandard generics and counterfeit medications are burgeoning because of the cost of branded antibiotics. Poor people often buy them from uncontrolled street vendors and, even then, cannot afford to complete a full course of treatment.

Love (2008) notes that, with worldwide growth of resistance, new antibiotics are increasingly needed. However, research and development are expensive, particularly for clinical trials involving people, and product development can be a lengthy process – two unattractive features for risk-adverse investors. Love (2008) also notes that the use of high prices as an incentive for investment is also associated with spending on costly – and sometimes misleading, irrational, or harmful – marketing practices, including cases where the owner of a drug exploits the monopoly by encouraging the use of medicines even when they are not appropriate. Love uses the drug Vioxx, which was marketed widely to patients for whom the risks were high relative to the benefits, as an example. Love (2008) recommends, for antibiotics, a reward system of cash prizes, using models similar to those used to value stock options, inventories, and other financial instruments. A new antibiotic would be valued not only for its use during the patent term, but as part of an ongoing portfolio of products needed for new diseases, conditions, or resistance problems that are expected to emerge over time.

Finally, antibiotic-resistant diseases are not the only problem. Cox (2008b) reports that, in 2002, the newly created US Department of Homeland Security (DHS) was given control of Plum Island Animal Disease Center in New York. At present, DHS is seeking a home for a National Bio- and Agro-Defense Facility (NBAF) that would take over Plum Island's work, along with its potent microbial cultures. The fact that many diseases are now known to jump between humans and animals, combined with this decade's terror fixation, has

led the federal government to convert the agricultural problem of sick livestock into the national security problem of bioterrorism. Love (2008) further comments that the new facility will be run by administrators drawn from the same pool as those who responded to the only actual bioterrorist attack in the United States to date – the anthrax mailings of October 2001 – and who have made virtually no progress in solving them.

The "Value Free" Delusion

In the United States, influential groups of environmental educators regard advocacy as a form of coercion. As Cairns (2002) examines the controversy in the field of environmental education over the role of advocacy versus "value free" presentation of scientific information, she notes that the former involves a view of education as process, while the latter perceives education solely as content. However, environmental issues involve ethical concerns and value judgments. For example, MacKenzie (2008) discusses the end of human civilization and notes that recent insights from fields such as complexity theory suggest that these concepts may be correct since, once a society goes beyond a certain level of complexity, it becomes increasingly fragile and passes a tipping point.

Actually, just as no activity involves zero risk, value judgments cannot be avoided. Surely the end of civilization, resulting from nuclear war, bioterrorism, or losing a climate favorable to humans, is a major cause for concern, and advocating taking steps to avoid the collapse of civilization is a common sense value judgment with which most people would agree. Such advocacy has a place in the social contract. This common sense judgment is needed in the context of a preponderance of scientific evidence indicating that, if present trends of greenhouse gas emissions continue, much human suffering will occur. For example, sea level rise caused by global heating could produce as many as 25 million environmental refugees from the Bangladesh delta alone. Surely this scenario should not occur, and most people would agree that steps should be taken to prevent this from happening.

No human activity is value-free and acknowledging values openly should, ideally, lead to a free and open discussion that may lead to actions that would prevent much human suffering. Also, as Cairns (2002) remarks, scientific information cannot give the answers to environmental questions, as these questions have all the inherent complexity of any social issue. The value-free delusion will, at best, avoid facing unpleasant truths and, at worst, increase human suffering and mortality by being an obstacle to change that might produce a more effective social contract.

Conclusions

Global climate change and "klimakatastrope" are everybody's problem, but some people, including some very powerful politicians, have yet to accept that humans are responsible for climate change. Tierney (2008) remarks:

> We can't even prepare properly for something as straightforward as our own retirement. We'll put in long hours shopping for a cellphone or a television set, but we're too busy to agonize over pension plans: in one study, most people spent less than an hour choosing theirs. We're not good at making immediate sacrifices for an abstract benefit in the future. And this weakness is compounded when, as with climate change, we have a hard time even understanding the problem or the impact of our actions today.

When humans acquired fossil fuels, the cheap, abundant energy enabled them to develop technology so that the population quadrupled in the period between 1900 and 2007. In 1900, the estimated human population

was 1.6 billion and, in mid-2007, was 6,602,224,175. The world's present rate of growth is 1.3%, which is a doubling time of 54 years. This number is ruinous for a species designated *Homo sapiens* (wise man). This growth means doubling the food supply, educational system, energy supply, hospitals, police forces, housing, and water supply every 54 years on a finite planet where 1 billion are starving and 2 billion are malnourished, poorly housed, and have inadequate medical care. When I ask people what they think will happen, the most common response is that something (usually technology) or someone (usually a deity) will save humankind. However, with approximately half the world's population living at a subsistence level or worse, this hope is probably false. Besides, if the human species has been designated "wise," perhaps it should use its brain to solve problems that, if left unresolved, will threaten human society's stability and even humankind's survival.

The genus *Homo*, in which *Homo sapiens* belongs, has lived sustainably on Earth for approximately 2 million years. However, in the last two centuries, abundant, cheap energy and the technologies it made possible have resulted in a huge population increase unprecedented in human history. This growth was accompanied by a huge increase in resource consumption that is not sustainable. Last, and far from least, anthropogenic greenhouse gas emissions are markedly changing Earth's climate, and the rate of emissions is still increasing dramatically. Science relates what is happening and what must be done to avoid further rapid climate change. When *Homo sapiens* was a small, tribal species spread thinly over Earth, no corporations existed and the assault on natural systems was at a tribal rather than an institutional level. Corporations have no inherent ethical/moral values. Their goal is profit, otherwise they have no incentive to exist. Naturally, they sometimes use advertising to seduce humans into addictions to some unhealthy practices, such as smoking, and other practices harmful to the biospheric life support system, such as profligate use of fossil energy, which has resulted in global climate change. None of this destruction could have happened if humans had placed the integrity of the biospheric life support system ahead of consumerism and economic growth.

A tension has always existed between politics, religion, and science. Perceptions that science was undermining political ideology or religious faith have been fatal to some scientists. In the 21st century, some corporations feel threatened by scientific evidence and fund organizations that attempt, often successfully, to discredit scientists and their research. Some governments attempt to censor scientific reports and restrict interactions between government scientists and the general public. In the long run, governments that attempt to censor scientific reports will become less competitive internationally. Science is far from perfect, but errors are soon detected by the scientific process, which is generally supportive of the preponderance of evidence – a rather conservative approach.

In the terms of values, one must first ask: "Should nature just take its course?" (Lovelock 1988, p. xviii). This position is the one humankind is taking on the three most important issues of these times: (1) global climate change, (2) human overpopulation, (3) ecological overshoot. Lovelock (1988, p. 11) asserts that malign effects have occurred from the 19th century separation of science into neat compartments where specialists and experts could ply their professions in complacency. In contrast, Lovelock (1988) focuses on a planetary perspective in which it is the health of the planet that matters, not that of some individual species of organisms – or, one might add, a homocentric economic system.

Humankind is turning a planet that has been hospitable to the genus *Homo* for 2 million

years into a planet with increasingly inhospitable conditions. Humankind professes a regard for its descendants and some people profess a regard for other life forms, but the practices of humans are not congruent with their stated values. A preponderance of scientific evidence shows that humans are changing Earth's climate, and these changes, likely to be less favorable to human life and many other species, will continue until anthropogenic greenhouse gas emissions are drastically reduced. Even then, since carbon dioxide has a long residence time in the atmosphere, the outcome will probably not be evident for a century. Some illustrative questions follow that might help to better define value systems.

(1) How much is humankind willing to change to protect posterity and other life forms that collectively comprise the biospheric life support system?

(2) Will these goals be expressed in numerical terms (e.g., reduction in greenhouse gas emissions) associated with specific times (e.g., years)?

(3) Will humankind agree to stay within Earth's carrying capacity for humans?

(4) Will the goal be at a subsistence or quality level?

(5) If climate change reduces Earth's carrying capacity for humans, are they willing to adjust population size accordingly?

(6) The "do nothing" default position is let nature take its course, which will produce starvation and death on a scale unprecedented in human history. May it not be so!

Former US Vice-President Gore once remarked that the United States could be a leader in controlling anthropogenic greenhouse gas emissions that are a major factor in global climate change. However, Kristof (2008) puts that idea to rest. In the United States, neither science nor literacy is faring well. Americans are as likely to believe in flying saucers as in evolution. Depending on how the questions are asked, roughly 30-40% of Americans believe in each. A 34-nation study found Americans less likely to believe in evolution than citizens of any of the countries polled, except Turkey. Kristof (2008) further remarks:

> President Bush is also the only Western leader I know of who doesn't believe in evolution, saying 'the jury is still out.' No word on whether he believes in little green men. Only 1 American in 10 understands radiation, and only one in three has an idea of what DNA does. One in five is convinced the sun orbits Earth . . . oh, oops " (Kristof's oops).

One of the most disturbing comments was:

> From Singapore to Japan, politicians pretend to be smarter and better-educated than they actually are, because intellect is an asset at the polls. In the United States, almost alone among developed countries, politicians pretend to be less worldly and erudite than they are (Bill Clinton was masterful at hiding a brilliant mind behind folksy Arkansas sayings about pigs).

With the planet in imminent peril, humans need to rescue both science and values.

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