April 20, 2006

The Economics and Politics of Ecology

The Industrial Revolution was a disaster for the human race - The Unabomber, 1996

Long before the systems of the planet buckle, democracy will disintegrate under the stress of ecological disasters and their social consequences - Ross Gelbspan, 1998

The bourgeoisie, during its rule of scarce one hundred years, has created more massive and more colossal productive forces than have all preceding generations together. Subjection of nature's forces to man, machinery, application of chemistry to industry and agriculture, steam navigation, railways, electric telegraphs, clearing of whole continents for cultivation, canalization of the rivers, whole populations conjured out of the ground - what earlier century had even a presentiment that such productive forces slumbered in the lap of social labor - Karl Marx and Friedrich Engels - The Communist Manifesto, 1848.

History shows that every technical application from its beginning presents certain unforeseeable secondary effects which are more disastrous than the lack of the technique would have been - Jacques Ellul, The Technological Society

The truth is, every technology creates a temporary island of order at the expense of greater disorder to the surroundings - Jeremy Rifkin, Entropy 1980

Nature is like a wild animal that you have trained to work for you. So long as you are vigilant and walk warily with thought and care, so long it will you its aid give; but look away for an instant, be heedless or forgetful, and it will have you by the throat -Kamala Markandaya, The Nectar & the Sieve.

Mankind is in the process of conducting a major, unintentional experiment, that of feeding back into the atmosphere in a short space of geological time the fossil fuels that have lowly accumulated over the past 500 million years...Roger Revele, Professor of Science and Public Policy, The University of California

Some day people will look at us driving gasoline-powered cars the way we look at our ancestors emptying chamber pots out the window - Peter K. Page, New York Department of Environmental Protection

... the stakes are well beyond the national interest, because nonparticipation of the United States in the global effort on climate change is more than a national embarrassment. It's dangerous. Donald Kennedy, editor and chief*, Science,* 299(17 January, 2003, p. 309).

Tell me, is there any other state in the world that permits its own population to be poisoned? - Tulepbergen Kaipbergenov, from Karakalpakia, Uzbekistan to the Soviet Congress of People's Deputies, 1989 [quoted in Feshbach and Friendly, p. 73].

Nature cannot be cheated - Ralph Waldo Emerson

Most ecosystems on Earth have been profoundly altered by human activity, and "no ecosystem on Earth's surface is free of pervasive human influence" [Peter Vitusek et al, Human Domination of Earth's Ecosystems, *Science,* 277 (25 July 1997), p. 494]. Indeed, the "functioning of Earth's ecosystems cannot be understood without accounting for the strong, often dominant influence of humanity" [ibid, p. 494]. "Human enterprises" such as "fishing, agriculture, industry and international commerce" have transformed the surface of the land, altered "major biogeological cycles," caused "irreversible losses of biological diversity" and are driving global climate change [ibid, p. 494].

Human activity affects the "ecological integrity" of the earth in many ways [Nicholas Mercuro ed. (1997) *Ecology, Law and Economics,* 2nd edition, p. 64]. The concept of Ecological integrity "is intended to imply a condition of unimpaired quality or a state of being complete and whole" [ibid, p. 64]. Moreover, the concept suggests a "correspondence with some original condition together with the capacity to support and maintain a naturally regulated, integrated, and adaptive biological system" [ibid., p. 65]. More often that not the ecological integrity of our natural environment has been compromised as an

The ecological footprint (EF) is a measure of the consumption of renewable natural resources by a human population, be it that of a country, a region or the whole world. A population's EF is the total area of productive land or sea required to produce all the crops, meat ,seafood, wood and fibre it consumes, to sustain its energy consumption and to give space for its infrastructure. The EF contains an element that requires the absorbing of all wastes. Thus, in developed countries, a large share of EF is forested land required to absorb CO2 emissions [K. Hubacek & S. Giljum, The Use of Input-Output Analysis to Estimate Land Appropriation of Trade activities, *Ecological Economics* 44 (2000), p. 139]. The EF, then is compared with the biologically productive capacity of land and sea available to that population.

The Earth has about 11.4 billion hectares of productive land and sea space - about 1/4 of its total surface area. Divided by the global population of six billion people, this equates to just 1.9 hectares per person. While the EF for the average African or Asian consumer was less than 1.4 hectares per person in 1999, the average Western European's footprint was about 5.0 hectares, and the average North American's was about 9.6 hectares. The EF of the world average consumer in 1999 was 2.3 hectares per person, or 20% above the earth's biological capacity of 1.9 hectares per person [up from 70% in 1961]. In other words, humanity now exceeds the planet's capacity to sustain its consumption of renewable resources. We are able to maintain this overdraft on a temporary basis by eating into the earth's capital stocks of fish and fertile soils. We also dump our excess carbon dioxide emissions into the atmosphere. Neither of these two activities is sustainable in the long-run - the only sustainable solution is to live within the biological productive capacity of the earth. [excerpted from World Wildlife Fund - Living Planet Report, July 2002]

unintended consequence of human activities directed toward technological change and economic development.

Ecological integrity can imagined at two levels; in terms of scope and scale. At the *Macro-environmental level* we encounter problems that have implications for ecological integrity with a global scope, e.g. global warming and climate change, ozone depletion, resource depletion (e.g. soil, metals and energy), the consequences of war and especially, nuclear war, acid rain, and the loss of biodiversity.

Other environmental problems, of a more limited scope, can be described as *micro environmental* problems. For example, lead poisoning, air pollution, ground water pollution, the release into the environment of substances, known as POPs (persistent organic pollutants) that, depending on dose, are toxic to cells, carcenogenic, or disruptive of the endocrine system. POPs are pesticides, PCBs and dioxins which, while serious, are usually understood in terms of diminishing the integrity of only local ecosystems. As we shall see, however, this is not always the case. Similarly, various forms of air pollution (black carbon, SO2) though usually local or

Minamata Disease

During the 1950s a POP horror story emerged on the island of Kyushu in Japan. For years, a plastics factory had been dumping inorganic mercury into Minamata Bay where many of the local people earned their living as fishers.

Mercury is the only metal that is liquid at room temperature so it looks like liquid silver. Ironically, if one were to drink it, one would suffer no harm. The "quicksilver" would simply pass through the GI system and be excreted. Inorganic or "elemental" mercury can also either be inhaled or absorbed through the skin. If so, it is a well-known occupational hazard that produces serious neuropathy and "emotional instability" - remember the "Mad Hatters" in Alice in Wonderland? However, should one ingest or inhale "organic" mercury the results would be tragically different.

Organic mercury is considerably more toxic than inorganic mercury. It is water soluble and is absorbed by body cells. It attaches to red blood cells and flows into the brain where it destroys the cells that control muscular coordination, speech, vision, hearing and other essential functions. Death can also result. In 1972, 459 Iraqis died when they ate wheat that had been sprayed with a fungicide that contained organic mercury.

The tragedy at Minamata was consequent to the activity of bacteria on the anaerobic bay bottom that converted the inorganic mercury into methyl or "organic" mercury .

The methyl mercury produced by the bacteria then bio-accumulated up the food chain from algae to zooplankton and eventually to the larger fish and on to the humans that ate them.

The first sign that something was amiss was when the village cats began to run through town howling just before they jumped into the bay and drowned. Then the people started to complain of "vague maladies" including "fatigue, headaches, and numbness in their extremities."

The immediate toll was 44 dead and twenty-two brain-damaged babies born. When it was finally over there were 700 deaths, 9000 cases of brain damage and paralysis. Another 50,000 suffered some degree of mercury poisoning, and it is estimated that as many as 25% of the area children are "mentally deficient" [Anne Nadakavukaren (1995) *Our Global Environment*, p. 272-4].

In the United States, fish caught in Lake Onondaga, near Syracuse New York cannot be eaten because of unsafe concentrations of methyl mercury. The mercury had been dumped into the lake between 1946 and 1953 by a factory that made chlorine and sodium hydroxide. Mercury was used as a solvent in the process. It is estimated that some 11 pounds of mercury were deposited in the lake every day over the period [The American Chemical Society, Chemistry in Context, 2nd ed,, p. 236].

regional concerns, are now seen in global terms as affecting the "radiative balance of the atmosphere" and thus influencing, in one way or another, the course of global warming and climate change [John Reilly, et al, *Multi-gas Contributors to Global Climate Change, Pew Center on Global Climate Change*, 2/2003, p.vi].

At the extreme the local problem is on the "Coase scale" involving only a small number of individuals. In such cases, the solution is often a matter of simple bargaining among individuals, and may not require government intervention at any level. Other local problems may be of a small scale and can be handled within a locality or a state. However, even what is essentially a local environmental problem can be realized on a massive scale. For example, water pollution in China is local in scope, that is, the sources of the pollution of the water resource are local or regional (human waste, agricultural run-off, industrial wastes. But, due to a lack of controls, or weak enforcement of those that exist, virtually all of China's lakes and rivers are polluted on a massive scale. The scale of the problem may prove larger than any local, state, prefecture, or even the national government can cope with.

One needs to make the discrimination between Macro and Micro pollution because the nature of the pollution is integral to the likelihood of reducing it. Regardless, of the scale of a problem, if it is local it can, at least potentially, be mitigated by the local authorities, assuming, of course, that there is the will and the resources to do so. As the scope of a problem expands, however, so does the need for cooperation among communities, states, and nations, if it is to be mitigated. China can solve its water pollution problems, but Japan cannot solve its air pollution problem unless China cooperates. Despite an intense effort to reduce its air pollution, the quality of the air in Japan (and Korea) suffers from pollutants blown in from China on the prevailing westerlies.

The need for international cooperation is more obvious in the attempt to mitigate global warming. Whatever, a single state, province or nation does to reduce greenhouse gas emissions, it will have at best a negligible effect on climate change - every nation is, in effect, a "climate taker." In the absence of any "world government" with the power to enforce cooperation, greenhouse gas reduction faces the classic "public good - free rider" problem, and accordingly the chances of mitigation are minuscule. The outcome will more likely be one where each nation deals with the consequences of climate change individually. This is a consequence causing not a little concern among the Island nations of the South Pacific who have no conceivable defense against inundation as sea levels rise in the wake of climate warming.

Macroenvironmental Problems

Global Warming

Greenhouse gasses are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. Temperatures are, in fact, rising. The changes observed over the last several decades are likely most due to human activities, but we cannot rule out that some significant part of these changes is also a reflection of natural variability... Despite the uncertainties, there is general agreement that the observed warming is real and particularly strong within the past 20 years - The National Academy of Sciences, 2001.

There is new and stronger evidence that most of the warming observed of the last 50 years is attributable to human activities - United Nations Intergovernmental Panel on Climate Change, 2001.[1]

The year 2003 will be remembered for the heat wave that killed about 15,000[2] people in Europe. 2003 was the third hottest year of the last 150, or about .81F higher than the normal 25.2F[3] [Hot spot in 2003, AP, 12/17/2003]. We have just discovered that 2005 was the hottest year in the past century. All of the three hottest years have been among the past six years with 1998 the hottest with an average temperature .99F above normal. The European experienced dwarfed that of the US toll of 150 during the July 1999 heat wave.

Global warming over the past century of about .5 degrees centigrade has been well documented. and its primary cause is generally believed to be "human activities" particularly the burning of fossil fuels. Deforestation also contributes significantly to the problem. As both activities are carried on worldwide, the problem is clearly global in scope. That said, it is clear that certain areas of the globe, namely the industrialized nations, bear the bulk of the responsibility for the problem, and some areas, most notably the Island Nations of the South Pacific, that have done little to contribute to the problem, nonetheless face its serious consequences, most notably rising sea levels due to the thermal expansion of the oceans and the melting of glaciers and the polar ice caps. In recognition of the potentially catastrophic consequences of climate change, nearly two hundred nations, including the United States, signed an agreement in Kyoto, Japan in 1997, that required substantial reductions in emissions of carbon dioxide. Unfortunately, however, China, India and many other developing nations, refused to participate. These nations contended that being forced to reduce emissions of greenhouse would seriously compromise their economic development. Similarly, President Clinton, even though he signed the protocol, knowing it had no chance, did not bother to submit the treaty to the US Senate for ratification. The Bush Administration that followed Clinton then openly repudiated the treaty on the grounds that it would be too costly to the US economy. As of early 2003, Canada and Russia were leaning in the same direction. Bush instead has decided to focus US efforts on remedial means for dealing with the consequences of climate change.

Thus, even should most of nations of the world act to reduce their emissions of greenhouse gasses as required by the Kyoto Protocol, the absence of the United States, Canada,

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[1]Both of the quotes here are from Andrew Revkin, Global Warming: All That Hot Air Must Be Having Some Effect, *New York Times*, 1/12/03.

[2]Most of these deaths, some 10,000, happened in France where air-conditioning is relatively uncommon. In light of global warming, France and other nations are now confronted with prospects greater need for electricity to run air-conditioners. In light of Kyoto tghe only option would appear to be nuclear power. One observed has noted that Europe's choice between global warming or nuclear power is like that of choosing plague instead of cholera [Heather Timmmons and Eric Pfanner, After Heat Wave Europe Gives Nuclear Another Look, *New York Times*, 9/18/2003]

[3]Remember the global average includes Greenland and Antarctica and other very cold places.

China and India from the list participants assures any efforts on the part of others will be in vain. Consequently, the earth will surely get warmer, but just how much is uncertain and consequently so are the consequences..

The Intergovernmental Panel of Climate Change, a group of over 2000 scientists brought together under the aegis of the United Nations predicts a rise of 2.5F to 10.4F degrees over the next century depending on population growth, consumption and energy conservation. Much of this temperature increase is due to the current loading of greenhouse gasses and future emissions at the hoped for lower rates. Thus, even should the Kyoto Protocol be fully implemented, only a "mere .1F will be shaved off that (IPCC) range" [E.O. Wilson (2002), *The Future of Life*, p. 68].

Conservation biologist, E.O. Wilson gives us some idea of the global disaster we can expect as the earth warms:

> More frequent heat waves, violent storms, forest fires, droughts, and flooding are the spawn of the historically unprecedented pace of climate change. Polar ice caps are destined to weaken: in the summer of 2000 an icebreaker made it through the thin and disappearing ice all the way to a mile-wide pool of open water at the North Pole. Sea levels, if the trend continues, will rise by four to thirty-six inches. Shallow coastlines around the world will shrink. In the Pacific and Indian Oceans, many atolls, including the small island nations of Kiribati, Tuvalu, and the Maldives, will partially disappear. Real Estate investment in New Orleans and the Florida Keys, not to mention the Bahamas and New York City, will seems and increasingly poor long-term risk [Wilson, *The Future of Life*, p. 68].

The Ozone Layer

The people of Punta Arenas in Chile must now keep their children indoors on certain days when the ultra violent radiation from the sun reaches dangerous levels. Even on normal days, long sleeves and sunglasses are normally worn, and 50 level sunblock applied. The reason is that the hole in the ozone layer at the south pole, first discovered in the 1980, has doubled in size[4] since then and now exposes this small town (125,000) near the Straits of Magellan to dangerous levels of solar UV-radiation [Larry Rother, In an Upside Down World, Sunshine is Shunned, *New York Times*, 12/27/2002]. Surely, the inhabitants of this town did little to contribute to causing this problem, but they are surely the victims.

In 1991, NASA reported that the ozone layer was being depleted at a rate that would result in some 200,000 excess deaths from skin cancer in the United States alone [Lester Brown et al (1998) State of the World 1997, p.155].

The cause of the problem is highly persistent organochlorine molecules or chloroflorocarbons (CFCs) that are used for refrigeration, air conditioning, and aerosol sprays, and some scientists now say, global warming, all of which deplete the ozone layer in the upper atmosphere that absorbs UV radiation. Depletion of the ozone layer threatens humans directly with epidemics of skin cancer and glaucoma, and indirectly through its deleterious effects on

[4]It is now as big as North America [Rother, *New York Times*, 12/27/2002]

many flora and fauna on which we depend for food. For example, krill which are the foundation of many aquatic food chains would be killed by high levels o f UV radiation and the immune systems of many plants and animals, including that of humans, would be compromised.

While the Montreal Protocol, which was ratified by 150 countries, has led to reduced production of CFCs they are still being used in many parts of the world released and into the atmosphere. Even should the terms of the Protocol be followed, the ozone layer would not be restored until 2045 [Brown et al, 1997, p. 152] Moreover, as they are much cheaper than the new substitutes intended to replace them, there seems to be an active black market for these substances which are illegally produced in India, China and Russia and sold even in the United States. In 1995, smuggled CFCs seized in Miami were second in value only to interdicted drugs. Overall, the government has seized 450 tons of the substance [Brown et al, 1997, p.168].

Microenvironmental Problems

Growing populations and rising consumption standards in the developed and developing countries threaten to destroy forests, fisheries, soils, water supplies, and to eradicate millions of species of flora and fauna, and many indigenous peoples. As the "ecological foot print" of the growing human population rises in the face of the natural limits placed on human activity by ecosystems, these ecosystems will be destroyed or altered in such a way that the ecological services derived from them will be lost. Moreover, the technological fix often produces unforeseen consequences that are even worse than the original problem. For example, the people in hundreds of villages in Bangladesh, one of the most densely populated and poorest nations in the world, are being poisoned by the arsenic in their well water. The people were driven to well-water because natural sources of water, rivers and ponds, were heavily polluted with human and industrial wastes and their waters unsafe to drink. The arsenic has been released into the well-water as a consequence of the dropping water table which in turn was a consequence of the use of ground water for irrigation. This is the ecological story of the past and the prospect of the future. The technological "solution" to one ecological problem produces an even more serious and intractable problem.

Biodiversity

The one process ongoing in the [present] that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly our descendants are least likely to forgive us. E.O. Wilson, 1980

The equatorial rainforests which contain "more than half of the known species of organisms" on a mere 6% of the earth's land surface are, to use E.O Wilson's term, "an abattior of extinction" [Wilson, The Future if Life, p. 59]. These forests are disappearing rapidly, with an area equal to the size of Florida disappearing each year [Wilson, p. 60]. Along with the forest goes the soils, the flora and fauna, and the indigenous peoples who have inhabited these forests for thousands of years. This "biotic impoverishment" of the earth's forest ecosystems raises both ethical and practical issues [Mercuro ed. p. 65].

At least since biblical times, it has been the presumption that all life forms on earth were

inferior to humans and were placed on earth for humanity to do with them as it wished. Humans, however, were active in their role as "serial killer of the biosphere" long before the descendants of Abraham sat down to write the scriptures [E.O. Wilson, 2002, p.94]. It is now fairly well established that aboriginal humans were responsible for the mass extinction of thousands of species of megafauna in North America, Australia, Madagascar and New Zealand [E.O. Wilson, 2002, p.90-95]. "As a rule around the world, wherever people entered a virgin environment most of the mefgafauna soon vanished." [p. 92] "First to go," writes E.O. Wilson, were the "big, the slow and the tasty" [p. 92]. Wilson has observed that the "somber archaeology of vanished species has taught us the following lessons[2002,p. 102]:

- The noble savage never existed
- Eden occupied was a slaughterhouse
- Paradise found is paradise lost

The "megadeath" of other species continues in the present. Now the victim species are "fishes, amphibians, insects and plants"[Wilson, 2002,p. 98] and the primary means is habitat destruction and pollution. E.O. Wilson projects that unless human behavior changes, about 20% of all living species will be gone by 2030, and 50% will disappear by the end the 21st century [p. 102]. If current trends continue the future of humanity in the next century will be one of "loneliness" where everything wild and natural will be gone. Our world will be one of "silent springs,' "synthetic jungles" and "barren scrub land" where humanity will have to engineer ecosystems to replace those it has laid to waste [Wilson, 2002, p. 77].

Ironically, it is from the Judeo-Christian religions that we see the greatest outrage expressed about the rape and ruin of then natural world. Pope Paul II declared that "ecological crisis is a moral issue" [quoted in Wilson, 2002, p. 158]. Similarly, Patriarch Bartholomew I of the Orthodox Church pronounced it sinful for "humans to cause species to become extinct and to destroy the diversity of God's creation" [quoted in E.O. Wilson, 2002, p. 158]. Similar sentiments have been expressed by various Protestant denominations. But, one need not require religion to establish a ecology friendly morality.

Philosophical movements such as Deep Ecology, Ecofeminism, Ecological Anarchism and Animal Rights and others have adopted an *ecocentric ethos* that attributes intrinsic worth to other species. Thoreau, for example, was able to relish an aspect of nature even though it had no practical or aesthetic value to humans - "shall I not rejoice also at the abundance of the weeds whose seeds are the granaries of the birds?"[quoted in Shabecoff, *Greenfire*, p.53]. Consequently, humans are held accountable for their treatment of other species whether it involves using animals in medical tests or destroying species' habitats and even lowly weeds. It is precisely this ecocentric ethic that leads to calls for a drastically reduced human population so that more of the wold can be left wild and to "ecotage" of projects that threaten wilderness areas and other species. Thoreau himself once toyed with the idea of taking a "crowbar against the Billerica dam" which interfered with the upstream migration of the Shad [quoted in Shabecoff, "*Greenfire*, p. 53].

There are, of course, "practical" or utilitarian reasons why humans should wish to conserve biodiversity. First, humans have a deep, possibly instinctual, emotional attachment to the wild world which E.O. Wilson has named "Biophilia." [Wilson, 2002, p. 134]. Biophilia is

the reason behind the emergence of the environmentalism in the United States. It is why men like Henry David Thoreau, John Muir, Aldo Leopold, George Bird Grinell and Theodore Roosevelt promoted wilderness protection. It is why we stand in awe before an Ansel Adams' portrait of the Yosemite Valley, a Thomas Cole landscape of the Hudson Valley wilderness, or James Audubon's portraits of birds, and why we take the dogs we love for a walk in the woods or in the park. It is why virtually every dystopia ever imagined features a world in which the ecological integrity of a place has been severely compromised.

In 1793, Reverend Nicolas Collins warned the American Philosophical Society of the need to protect birds from the extinction to which they seemed destined due to the relentless hunting for their feathers and for sport. Birds need to be protected, he insisted, until the "role in the Oeconomy of nature" was understood [quoted in Phillip Shabecoff, *A Fierce Green Fire: The American Environmental Movement*, p. 1993, p. 46]. In short, Rev. Collins, like the conservation biologists and environmentalists of today, understood that the extinction of birds may present problems for humans in the form of lost of ecological services. Viewed from an anthropocentric perspective, birds control many "pest" insects that can do great harm to crops and spread disease among humans. There is a fundamental ecological truth then in Thoreau's assertion that "in wilderness is the preservation of the world"[quoted in Shabecoff, p. 46].

Similarly, one could argue, again from an anthropocentric perspective, that preservation of tropical rainforests is essential so that humans can "bioprospect" for plants with medicinal properties, and to provide a "sink" for the carbon released in to the atmosphere by industrial processes.

The concept of ecological integrity is manifest in the relationship between the problems of global warming and species extinction. Every species, including Homo Sapiens lives in a niche in a food web where it gets its food, and in which it is food for other species. The range of any given species (humans excepted) is very sensitive to temperature. Many essential aspects of survival such as mating patterns, egg laying, plant flowering, and migration to name just a few are driven by temperature signals. Of late, as global temperatures have been rising in the northern latitudes, species have begun to migrate toward the poles. There is, however, no reason to believe that an entire food web will migrate at the same pace, especially when it encounters barriers in the form of parking lots, highways and other human artifacts. Thus, it can be expected that many species will find themselves "out on a limb" when they migrate away from a food supply. Predators may find themselves left behind by prey species who have moved on or may face new predators. In Alaska, for example, warming has led to an explosion in the population of the spruce bud worm that, by 1998, had destroyed some 20 million hectares of trees [Brown et al, State of the World in 2000, p. 36].

Plants that rely on certain insects for pollination may find them absent when needed if the pollinators operate on different temperature systems. In short, climate change is throwing a monkey-wrench into ecosystems around the world, the effects of which are not likely to be salutary.

The blurring line

As noted above many of the disasters related to air pollution and POPs have been local in scope. In 2002, the American Electric Power Company purchased an entire town rather than

reduce the air pollution its operation produced. The 221 residents of Cheshire, Ohio in consideration of their pledge to not sue the company for damages to their health and property, were paid to leave their homes and their community. Since 1973 "about two dozen towns, have been bought by companies who so despoiled the towns with toxic chemicals or air pollution that they became unlivable [Katherine Q. Seelye, Utility Buys Town It Choked, Lock, Stock and Blue Plume, *New York Times*, 5/13/2002].

As recent events have revealed, however, air pollution generated in one place can do serious damage in other places that are downwind. In 2002, the Attorneys General of a eight states in the Northeast USA, have bought suit against the Bush Administration's policy of allowing electric utilities in the cental US to continue producing air pollution that harms the health and property of people in the Northeast.

Air pollution produced by new plants in Mexico drifts into the US and harms the fragile environment of Big Bend National Park. The Netherlands is known as one of the "world's dirtiest" nations primarily because it receives polluted water, and air from the rivers and the prevailing winds that flow and blow from the industrial heartland of Europe. Korea and Japan suffers a large burden from air pollution produced in China. China's use of coal for energy accounts for over a quarter of Japan's annual sulphur deposition [Brown et al, State 2000, p.34]. Indeed, in 1998, in Nevada, scientists recorded the highest concentration of atmospheric arsenic ever measured in the western United States. The source of this pollution, is probably coal burning in China [*Providence Journal*, June 2, 2002]. The fact is that the United States receives toxic metals, pesticides, viruses, bacteria, and fungi that are blown across the Pacific from China and the Atlantic for Africa in massive dust clouds by the prevailing winds. Several outbreaks of plant diseases in the United States and Canada have been traced to pathogens blown here from Africa [Janet Raloff, Ill Winds: Dust Storms Ferry Toxic Agents Between Countries and Even Continents, *Science News*, Vol 160, 10/6/2001, pp. 218-20].

These dust storms can be quite substantial. In April of 2001, a dust storm in the Gobi Desert in China sent enough dust to Boulder, Colorado to reduce sunlight by about 25% [Raloff, p. 218]. Nor is the phenomenon a new one. Ice cores drilled in Greenland reveal pollutants produced by smelting by the Greeks and Romans some 2000 years ago.

Persistent Organic Pollutants

Some 70,000 industrial chemicals are synthesized and sold in the marketplace. Many of these substances are "resistant to natural degradation processes so they gradually accumulate in the environment and are distributed across the globe on currents of wind and water. As a result, a cocktail of hundreds of thousands of man-made chemicals can now be found absolutely anywhere one the planet, from the deep oceans to the North Pole, from the Mississippi River to our own bloodstreams [Joe Thornton, Pandora's Poison: Chlorine, Health and a New Environmental Strategy, 1998, p.2]. These substances have caused a "dizzying array of environmental problems: DDT and the decline of bald eagles; toxic waste a Love Canal; cancer among Viet Nam veterans exposed to Agent Orange; chloroflourocarbons and the ozone hole; PCBs in polar bear tissue; herbicides in groundwater throughout the Midwest; dioxin in fish downstream from pulp and paper mills," to mention just a few [Thornton, p.2]. All of these problems stem from one class of chemicals - organochlorines. The latter are so named because

the include carbon (organic) and at least one atom of chlorine. To be sure, organochlorines are not the only source of pollution, heavy metals and many non-chlorinated synthetic chemical cause serious problems as well. But it is the organochlorines that provoked Rachel Carson to write Silent Spring in 1962, and it is the same chemicals that provoked a summit in Stockholm 2001.

Clearly, it is often hard to maintain the distinction between local and global environmental problems as there is growing evidence that local problems can become global. Toxic wastes are produced and used in specific locations, but some, as dioxins[5] and PCBs have become global problems.

In 2001 over 120 nations, including the United signed the Stockholm Convention which banned the production of 12 persistent organic pollutants[6] (POPs), most of which were pesticides, the remainder being PCBs and Dioxins. Virtually all of these "dirty dozen" had been banned since the 1970s in 50-75 nations (depending on the substance). DDT had been banned in 60 nations and Aldrin in 72. But, PCBs and dioxins were prohibited in nine and zero nations respectively. With the Stockholm agreement the number of nations banning or restricting the use of these substances doubled. Nevertheless, the use of many, most notably DDT, will continue in some developing nations.

The basis of the Stockholm Convention is the belief that POPs are associated with a number of problems in humans and animals including, several types of cancer (e.g. testicular, breast), reproductive dysfunction (e.g. infertility), birth defects (malformed penis, hermaphrodism) developmental problems (e.g. diminished IQ) and neurological disorders.

While produced or generated locally, POPs circulate globally. As one observer put it, "POPs do not respect national boundaries"[Brown et al, p. 91]. This occurs first because they are persistent in the environment, and through the so-called "grasshopper effect," that is, through repeated cycles of evaporation and condensation, they can migrate with the rains to the far

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[5]Dioxins are primarily (69%)"produced" as a byproduct of incineration of medical and other solid wastes that contain chlorine. Japan, with little space for landfills, has 3800 municipal incinerators compared to a mere 200 in the United States, and, thus, leads the world in dioxin emissions. Per capita emissions in Japan are three times the level in the United States. Total Japanese emissions of dioxin exceed those of the US by about 1/3. The Netherlands and Belgium have higher emission rates (per capita) than Japan. Indeed, the rate in Belgium is twice that in Japan, but total emissions are still less by a factor of six! Germany, Austria and Sweden have the lowest per capita rates of dioxin release from incinerators. Unfortunately, the developing nations are biased toward incineration of wastes so, in global terms, the problem can be expected to worsen over time [Lester Brown, *State of the World 2000*, p.84]. There is a glimmer of hope, however, in the fact that the people of the Phillippines prevented a French Company from constructing what would have the worlds largest incinerator just outside Manilla [Brown et al, p.96].

[6]The pesticides, most of which were included in Rachel Carson's analysis in Silent Spring in 1962, are Aldrin, Chlordane, DDT, Heptachlor, Hexachlorobenzene, Dieldrin, Mirex, and Toxaphene. Other substances include PCBs whcih are manufactured and manufacturing by-products such as polychlorinated dioxins and furans.

corners of the earth. Dioxins are produced by incinerators that shoot them up tall chimneys into the prevailing winds.

Little surprise then that although a product of modern industry, large concentrations of PCBs and dioxins are found in human and animal populations all over the world. One is not surprised to find high levels of PCBs in the general neighborhood of a manufacturing plant such as Monsanto's infamous operation in Anniston, Alabama. After 27 years of the careless disposal of waste into the ground, air and local rivers, researchers found soil concentrations of PCBs in Anniston to be 960 times the EPA's threshold of concern. The level in household dust was 200 times the threshold of concern. Not surprisingly, many of the residents that lived near the plant also had elevated serum levels of PCBs [Michael Grunwald, Monsanto Hid Decades of Pollution, *Washington Post*, 12/31/2001.

The problem of PCB contamination, however, transcends the local. In 1967, Swedish scientists found traces of PCBs everywhere in the food chain, fish, birds, pine needles and children's hair [Grunwald, Washington Post, 12/31/2001]. In fact, humans get their dioxin load from eating animals that have accumulated the substance in their body fat. The Inuit of northern Canada, due to their diet which is almost exclusively marine mammals and fish which are loaded with dioxin, have one of the highest dioxin loads of any human population in the world . In 2003, the report of a ten-year study on the effects of chemical contaminants in the Arctic claimed that "long standing villains such as pesticides, polychlorinated biphenyls (PCBs) , and mercury have been linked to weakened immune systems and developmental deficits in Inuit children" [Paul Webster, For precarious populations pollutants represent new peril, *Science*, 299, 14 March 2003, p. 1642].

The combination of bioaccumulation and persistence allows POPS to invade the web of life and to linger on almost indefinitely. Arctic cod have 1000 times higher concentrations of DDT per gram of fat than the zooplankton they consume. And herring gulls from Lake Ontario harbor nearly 25 million times the concentration of PCBs that are found in the surrounding waters.

Although DDT was banned from use 25 years ago in both the United States and Canada, enough of the synthetic compound is still present in the Great Lakes to reduce substantially the chance of eagles and other top predators will produce viable offspring. Even newcomers fall prey to this residual contamination. Within two years of migrating from pristine inland areas to Great Lakes shores, bald eagles suffer marked declines in fertility. For this reason, experts refer to the Great Lakes as a "black hole" for bald eagles. - excerpted from State of the World 2000, Lester R. Brown et al - p. 85.

Polar bears in the Canadian Arctic are suffering from global warming, have accumulated distressing levels of the fire regardant perflouro-octane sulfonate, and also from the disruptive effects of PCBs on their endocrine systems. As the earth warms, these polar bears are deprived of the ice from which they hunt seals, and thus are slowly starving. Moreover, scientists have observed a distressing degree of hermaphrodism[7] among these bears and link it to the high levels

[7]Hermaphrodism means having both testes and ovaries. Like other birth defects, hermaphrodism can occur naturally. But of late, wildlife scientists have been observing this defect at unprecedented rates. In 1998, scientists reported that 1/100 polar bears on the Arctic Island of Svalbard were hermaphrodites [Davis, 2002, p. 221].

of PCBs found in their body fat [Devra Davis, *When Smoke Ran Like Water*, 2002, p.278]. As these bears rely on body fat to survive the cold, and the expected effect of perflouro-octane sulfonate is to cause weight loss, it could "prove to be mortal" for some individuals [Webster, *Science*, 299, p. 1643]. One can presume that if these substances have found their way into polar bears in the Arctic, have they have found their way into apex predators, like humans, everywhere, and, there is mounting evidence that the same deleterious effects are becoming manifest.

Despite the disclaimers of the chemical industry and its PR toadies, there is an epidemic of breast cancer in the United States, and many reasonable people, and a great deal of research data strongly suggest that it is related precisely to PCBs and other "chlorinated organic materials" (pesticides, herbicides and fungicides) introduced to the world after WWII and have now proliferated the entire globe. In 1973, 100 white women per 100,000 developed breast cancer. By 1999 the rate had risen to 143/100,000. Among African American women the incidence rose from 82 to 123/100,000. [Devra Davis (2002), *When Smoke Ran Like Water*, p. 164]. In 2001, one woman in eight contracted breast cancer and 42,000 women died of breast cancer, the toll was similar in Europe [Davis, p. 165].

There is also mounting evidence that organochlorines appear to be wreaking havoc on males as well. Male production and workers and farmers exposed to organochlorines have lower sperm counts, and more dead and immotile sperm than unexposed populations [Thornton, p. 125]. Males are suffering higher rates of testicular cancer, birth defects such as undescended testicles and split penises, decreasing size of testes and infertility (lower sperm counts). Moreover, it appears that there are fewer males being born due to the hormonal effects of organo-chlorines on male sertoli cells, the so-called "boy-making cells" on the Y chromosome [Davis, op cit. P.211].

Air Pollution

It was by this time about nine in the morning, and the first fog of the season. a great chocolate-coloured pall lowered over heaven, but the wind was continually charging and routing these embattled vapours; so that as the cab crawled from street to street, Mr. Utterson beheld a marvellous number of degrees and hues of twilight; for here it would be dark like the back-end of evening; and there would be a glow of a rich, lurid brown, like the light of some strange conflagration; and here, for a moment, the fog would be quite broken up, and a haggard shaft of daylight would glance in between the swirling wreaths. The dismal quarter of Soho seen under these changing glimpses, with its muddy ways, and slatternly passengers, and its lamps, which had never been extinguished or had been kindled afresh to combat this mournful re-invasion of darkness, seemed, in the lawyer's eyes, like a district of some city in a nightmare - Robert Louis Stevenson, The Strange Case of Dr. Jekyll and Mr. Hyde - 1886.

The only drawback of this industrial conveniency is the darkness of its sky. The night and day are too nearly of a color... In the manufacturing towns, the fine soot or "blacks" darken the day,

give white sheep the color of black sheep, discolor the human saliva, contaminate the air, poison many plants, and corrode monuments and buildings. - Ralph Waldo Emerson, on industrial England in 1856.

If Emerson and Stevenson were writing today in a place like Mexico City, or any major city in China or Eastern Europe, little modification of their words would be required. In the developed nations, air pollution might not be so obvious, and, similarly so, the death and ill-health it causes. Be not mislead, however, air pollution still kills an alarming number of people each year, and diminishes the lives millions even when the skies are not darkened by soot.

Air pollution was really the first "pollution" to be observed by the public and still retains a great deal of public interest [Ehrlich & Ehrlich p. 131]. Air pollution has grabbed headlines when in some extraordinary cases levels became toxic and large numbers of people died. In London, for example, the quality of the air had not improved since Stevenson described it in 1886 when, in December of 1952, air pollution was so bad visibility at ground level was down to 1 to 5 meters and some 4,000 people died [Goklany p. 347].

The near freezing temperatures in December of 1952 had forced Londoners to pile more high sulphur coal into their heating stoves than usual. Unfortunately, a high pressure area over the city prevented the sulphur-dioxide laden smoke from dispersing. Schools were closed and a performance of *La Traviata* was canceled because the stage was barely visible through the smog [Richard Stone, *Science*, 298, 13 December 2002, p. 2107]. Over a 4 day period, some 4000 people succumbed to respiratory problems and/or heart failure. Over the next three months, as many as 8000 more "excess deaths" have been attributed to the "Great Smoke"[8][Stone, *Science*, op cit. P. 2107]. At a recent conference commemorating the 50th anniversary of the disaster, one commentator, epidemiologist Devra Davis, noting the WHO estimate of 600,000 annual deaths from air pollution, observed that "some lessons of the Big Smoke still haven't been learned"[Stone, p. 2107].

Air pollution is not merely a problem of "industrial societies." In the New World, for example, air pollution is a very old phenomenon. The first person to report the effects of a thermal inversion in Los Angles was Juan Roderiguez Cabrillio, in 1542. Rodriguez named the place he discovered, the "Bay of smokes" after the thick layer of smoke from Indian cooking fires that had been prevented from dispersing into the upper atmosphere by a layer of cold air that sat over the valley [Rene Dubos, *Man Adapting*, p. 202].

In 2002 the United Nations Environment Program reported the existence of a "two mile thick blanket" of air pollution over South Asia. This "grimy cocktail of ash, soot, acids, and other damaging airborne particles" is surely in part the consequence of industry and the automobile, but it is also to a very significant extent the consequence of "low-tech" energy use by billions of people. The use of wood and dung for cooking fuels, and the burning of forests to clear land for agriculture is contributing as much to pollution as does "dirty industry"[Jill Lawless, AP, Asian Pollution Leading to Illness, Deaths, *Providence Journal*, 8/12/02]. This air

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[8]At issue is whether the "excess deaths" (those above normal for the period) were caused by an influenza epidemic or the after-effects of the fog. Devra Davis, after a review of medical records, claims that flu could not have accounted for the excess deaths [Science, 298, 13 Dec, 2002, p. 2107]

pollution is causing an increase in respiratory problems mortality and mortality. In India alone it is estimated to cause 500,000 premature deaths each year [Lawless].

To make matters worse, the air pollution is so dense it reduces the amount of sunlight that reaches the earth by 10-15%, and consequently has changed the climate, in particular the pattern of the monsoon. Now the northeast of India and Bangladesh get dangerous levels of rainfall and severe flooding, while Northwest India and Pakistan are desiccating [Lawless]. Too little is known to determine to what extent this problem is global, that is to what extent prevailing winds might carry this "grimy soup" around the world [Lawless].

Nitrogen Oxides from millions of lightning machines

The Rose Bowl fog of 1982 had pH of 2.5 which made it something like a fine mist of vinegar. Another fog, in South LA fog in 1982 had pH of 1.5! Yet the SO2 concentration in LA air was relatively low. Could the millions of automobiles in LA somehow be responsible? The answer is yes, but not for the reason one would expect. Coal burning produces acid rain because there is sulphur in coal. But, LA's acid problem is from nitric acid, yet there is no nitrogen (and practically no sulphur) in gasoline.

In nature, lightning or an electric spark forms nitric oxide out of the nitrogen that is in the air ((NO - Energy + N2 + O2 → 2NO). Cars make NO as the internal combustion engine intakes air (N) and "sparks" it. The NO emission is then oxidized to form NO2. Nitrogen dioxide is a highly reactive, poisonous, red-brown gas with a nasty odor. When it reacts with sunlight and VOCs (unburned gasoline) we get HNO3 - nitric acid And, hence, LA's acid fog [A. Truman Schwartz et al, Chemistry in Context, 2nd ed. (19970 pp. 201-203]

The Indian campfires are long gone, but air pollution is still a problem in Los Angeles. WWII was a particular boon to Los Angles County. By the end of the war, some $19 billion defense spending had transformed Los Angles into the "nation's second largest industrial center" which had the "most vast and modern industrial structure in the entire world" [Garrett, Betrayal, p. 320]. During the five war years the population of Los Angles grew by 2.5 million or about 35%. The primary mode of transportation of these 9.5 million Angelenos was the automobile. Los Angels, had abandoned its commuter rail system in favor of freeways, and thus had become the world's first automobile commuter culture [Garrett, p. 321]. As early as 1943, the ecological consequences of the rapid growth of industry and automobiles had become evident. On July 23, 1943, know forever after , as Black Monday, "the entire downtown area [was] engulfed by a low-hanging cloud of acrid smoke" reduced visibility to about three blocks and "left thousands of Angelenos with irritated eyes, noses and throats" [Garrett, Betrayal p. 320]. By the end of the war, "smog" was a "nearly permanent feature of Los Angles" [Garrett, p. 320].[9] While Los Angeles was the first to suffer from "smog" it was soon followed by cities around nation and around the world as industry and the automobile proliferated. Over the next ten years, it would be discovered that in addition to the obvious nuisance of irritated eyes, noses and throats, that smog contained many chemicals, such as

[9]Films made in this period that were set in Los Angeles will have a yellowish tint, giving a very warm feeling. Such a coloration was not intended to produce a warm feel, but simply to reflect the color distortion produced the more or less permanent brown haze that covered the city.

hydrocarbons, carbon monoxide, nitrous oxides, sulphur dioxide, benzpyrene, ozone, and lead, that proved harmful to humans [Garrett, Betrayal p. 321]. Pubic alarm was elevated when animal tests showed that some of these substances were carcinogenic [Garrett, Betrayal, p. 321]. In 1958, a public health expert from Columbia University surely had Los Angeles in mind when he wrote:

> the atmosphere of the modern industrial community is a carcinogenic sea, polluted an made murky by many sorts of individual waste. In such an environment it is hardly possible to avoid daily contact with cancer producing agents...[quoted in Garrett, Betrayal, p. 322]

In the years that followed clean air legislation was enacted in the UK and the US and air quality has rather dramatically improved. The main impact of air pollution on health is its contribution to lung diseases such as respiratory tract infections, asthma, and lung cancer. Lung disease takes 300,000 lives per year, but there is no hard evidence as to what proportion of these deaths are caused by air pollution as opposed to other factors, most especially smoking. An American Cancer Society study, done in 1995, did control for smoking and other risks (e.g. occupational exposures and other air pollutants) and found an elevated risk of premature death for people living in cities with high levels of particle pollution.

There are many types of air pollution. The most commonly experienced by urban people is smog, the ugly brown haze that hangs over the world's cities. In Beijing, the springtime brings "a mantle of dust and pollution that cuts visibility to feet" [Providence Journal, 6/2/02, A-17]. In Beijing in spring on a sunny day in Spring the sky is "bright brown." On a rainy day is just a "darker shade " of brown. In Beijing, and many other cities of the modern world, the people live in a "sepia world"[Providence Journal, 6/2/02, A-17].

The principal sources of smog are hydrocarbon emissions from automobile exhaust, and the burning of fossil fuels, especially brown coal, for heating and electricity. While smog can produce a soft, warm light and beautiful sunsets it is a health hazard; it is a serious health hazard for many as it causes and exacerbates respiratory problems. In Los Angles[10] and other afflicted communities regular smog alerts warn people to stay inside and warn schools not to let children exercise outdoors. Burning fossil fuels emits ozone (O_3), carbon monoxide(CO), sulfur dioxide (SO_2), Nitrogen oxides (NO_x) and particulate matter (PM)[11].

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[10] Ozone is a major component of Los Angles' smog. Ozone does damage to lung tissue, and reduces lung function [Goklany 1995 p.355,362]

2. In addition to soiling the environment PM (Ash and soot) can aggravate respiratory problems and cardiovascular disease (diminished lung function makes the heart work harder to circulate oxygen). PM can also be carcinogenic, do damage lung tissue and diminish the ability to the lungs to reject other foreign matter [Goklany p. 354]. The exact toxicological mechanisms by which air pollution causes health problems are not well understood, but researchers have a number of theories. For instance, studies show that particulate matter causes changes in lung function, alteration of mucociliary clearance, and pulmonary inflammation which can lead to increased permeability of the lungs. Increased permeability might precipitate fluid in the lungs in people with heart disease. In addition, mediators released during an inflammatory response could increase the risk of blood clot formation and strokes. Particulate

Particulate matter, or particle pollution has been implicated in several studies as a significant cause of premature death may In the US, at least, EPA controls on auto emissions and smokestack emissions have reduced air pollution in most major cities, but the problem is far

The main constituents of air are nitrogen, N_2 (78%) , and oxygen, O_2 (21%). When exposed to intense heat such as lightening or that produced inside an automobile engine, these substances combine to make oxides of nitrogen, namely nitrous oxide (N_2 O), N O_2 or nitrogen dioxide, and nitric oxide (NO). In the presence of oxygen (O_2), sunlight can cause the N_2 O or N O_2 to break down and recombine with O_2 into N_2 and O_3. Until recently O_3, or Ozone, was found only in the upper atmosphere where it performed the useful function of blocking the sun's deadly ultra-violent radiation (UV radiation breaks down many molecules including DNA). Before the Industrial Revolution only lightening produced enough heat to produce ozone in the lower atmosphere. But, as lightening was infrequent, and ozone breaks down quickly (about 2 days) into normal oxygen, ozone did not pose a human health problem. Today, however, millions of automobiles produce ozone at such prodigious rates that on summer days many cities are covered with a reddish brown haze known as "photochemical smog." Smog is harmful to plants and to humans. Ozone acts a strong oxidizing reagent. It damages building materials such as paint, rubber and plastics. It has an acrid odor and damages sensitive tissues such as the eyes and lungs. Moreover, ozone damages the membranes of chlorophyll-containing mesophyll cells of plants thus impeding photosynthesis and stunting the growth of plants.

Ozone is also a powerful greenhouse gas.

from solved. In 1990 one-half of Americans lived in cities where ozone levels exceeded federal standards [Ehrlich & Ehrlich p. 131]. Indeed, irritants in the air produced by pollutants are so pervasive that about one-half of all the lungs in the United States, examined by autopsy have some degree of alveolar deterioration. The Office of Technology Assessment has estimated that 250,000 people in the US suffer from lung problems caused by air pollution and some 50,000 persons die from it each year [Cunningham and Saigo p. 397]. In 2003, researchers at Brigham Young University found that particulate matter poses a greater risk to the hearth than it does to the lungs. The study of 500,000 people, in 150 cities over 16 years, published in the journal, Circulation, found that the risk of ischemic heart disease increased by 18% for every increase of 10 micrograms of particulate matter in a cubic foot of air [Eric Nagourney, Consequences: Tiny particles put heart in peril, *New York Times*, Dec 16, 2003]. Since heart disease the number one killer in the United States this finding is of momentous consequence, and indicates the social costs of air pollution are actually far greater than previously thought.

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exposure might also increase susceptibility to bacterial or viral respiratory infections, leading to an increased incidence of pneumonia in vulnerable members of the population. Potential mechanisms could include impairment of clearance mechanisms or immune system function. In the presence of pre-existing heart disease, acute bronchiolitis or pneumonia induced by air pollutants might precipitate congestive heart failure. Particulate air pollution might also aggravate the severity of underlying chronic lung disease, causing more frequent or severe exacerbation of airways disease or more rapid loss of lung function. Particulate matter includes road dust, diesel soot, fly ash, wood smoke, and sulfate aerosols that are suspended as particles in the air. These particles are a mixture of visible and microscopic solid particles and small liquid droplets known as aerosols.

It is difficult to estimate the total costs from air pollution because the science is so complex, but "plausible" estimates run up to 70,000 deaths and untold millions afflicted with illnesses [Ehrlich & Ehrlich p. 131]. This estimate may be on the low side. A Natural Resource Defense Council study reported in 1996 found that "particle pollution" alone caused 1,000 deaths each year in San Diego and estimates that nationally 64,000 people[12] die as a result of particle pollution and life expectancy is reduced as much as two years in heavily polluted areas.

Oddly, conservatives typically claim first that air quality has improved greatly over the past three decades and that further improvements in air quality are not worth the cost [I. Goklany, Richer is Cleaner]. For example, a 1991 study of the potential of further air pollution control for Los Angles did not pass a benefit/cost appraisal. The researchers analyzed programs aimed at further reducing ozone and PM and concluded they would produce benefits of two billion dollars per year (save 2000 lives valued at one million each) but would cost thirteen billion per year [Goklany p. 377 fn. 76]. It is not the place to take such cost/benefit analyses to task, but suffice it to say there are many economists who believe that such studies systematically understate the benefits of anti-pollution efforts and overstate the costs. Even worse, Tufts University economists Frank Ackerman Lisa and Heinzerling, in a book titled "Priceless: On knowing the Price of Everything and the Value of Nothing," claim that cost benefit analyses while "cloaked in the language of scientific objectivity have repeatedly played a partisan role," especially "when applied to health and environmental policy" [2005, p.11-12]. In contrast, the EPA, not exactly a non-political organization, has estimated, for the nation as a whole, that the benefits of air pollution controls far outweigh the costs. Every dollar spent on pollution controls since 1970 has produced a gain of $45 in health and environmental benefits: fewer doctor visits, fewer work days lost, fewer hospitalizations, and fewer premature deaths. The EPA estimated that the cost of complying with the new standards proposed in 1997 at $6.5 - 8.5 billion per year, with benefits of $120 billion. Surely, Los Angeles has special and perhaps unique problems, but it seems that if anything it would be than the city has far worse than average air pollution making the benefits of further reductions larger than average.

The Clean Air Act of 1970 has produced dramatic improvements in air quality in America's cities primarily by reducing automobile emissions though the mandating of catalytic converters and other exhaust system technologies such as gasoline vapor recycling [Fumento p. 316]. The EPA reports that between 1975 and 1991 the average concentration of PM fell 24% and concentrations of other pollutants also fell: sulphur dioxide (50%), carbon monoxide (53%), nitrogen dioxide(24%), lead(95%) and ozone (25%). Nevertheless, despite the decline in the averages, millions of people live in areas where the EPA standard is exceeded. In Los Angeles, for example, the number of days where ozone exceeded federal standards has dropped from 186 to 88, obviously ozone remains a problem. Moreover, under the relentless pressure of population growth (60% since 1980), ozone levels are starting to rise again (up in 2003 and 2004, but dipped slightly in 2005). The 1990 Clean Air Act imposed tougher restrictions on emissions especially for those related to Ozone. The act requires the use of refueling controls on

[12] The elderly and those with heart and lung disease are at greatest risk of premature mortality due to particulate matter. In more polluted areas, their lives might be shortened by one to two years on average. areas.

auto and gas pumps, most stringent auto inspections, even more emissions controls on vehicles, reformulated gasolines (e.g. oxy-fuels). Such stringency in of no mean importance. A 2004 report of a ten-year longitudinal study of children in Los Angeles found than those living in the areas with the highest ozone loads had 10-20% lower vital capacity (the ability to inhale oxygen) [Barringer].

While the "urgent need to scrub the filthiest air in the country" has dominated the politics of the Southern California for the past fifty years, "success - consistently healthy air for all 16 million Southern Californians - remains out of reach" [Felicity Barringer, California Air is Cleaner, but Troubles Remain, *New York Times*, August 3, 2005]. For example, ozone pollution, while improving, is still bad enough to place Southern California among the worst three areas of the country [Houston, the San Joaquin Valley in Central California are the other two worst in the nation]. Even worse, the Ports of Los Angeles and Long Beach are the source of " a concentrated source of diesel pollutants (black carbon) spewing from ships, locomotives and lines of idling trucks" all part of the China trade needed to sate the "ravenous American appetite for cheap Asian goods"[Barringer, 8/3/2005]. A 1998 study revealed that cancer risk for residents of Long Beach was two to four times higher than in other parts of Los Angeles and that emissions black carbon from diesel engines accounted for 70% of the elevated risk [Barringer, 2005]. While some of these emissions are from trucks, most are form ships and trains which cannot be regulated by the State of California

Regional Pollution Problems

The main source of the air pollution problem in California is "emissions from cars, trucks, trains and ships" [Barringer, loc cit]. In the Gulf States it is the chemical and oil industries. In the Midwest the steel industry has been replaced by the electric utilities as number one air polluter. Due to the prevailing westerlies, the electric utilities in the Midwest export air pollutants to the Northeast. This basic ecological fact, combined with some less than salutary politics has posed a serious air quality problem for the Northeastern states.

The New Source Review program was enacted in 1977 as part of an amending of the Clean Air Act. The amendments required that any new electric generating plants and other industrial polluters install the best available technology for reducing air pollution. The program was a compromise that allowed existing capacity to avoid installation of expensive pollution control devices until the plants were renovated or expanded. Plants doing only "routine maintenance" were, in effect, exempt from the rules. Any plant that was to be renovated and expanded had to receive approval from state regulators who would insist that the BAT be used. Since 1977 few if any plants have applied for a new source review even though they clearly renovated and upgraded their capacity. During the Clinton Administration, the EPA brought suit against these plants to force them to spend some five billion dollars to add pollution control devices to the de facto upgraded plants. The Bush Administration has proposed new rules and held off the EPA suits. The Bush Administration proposed that environmental controls would not be required unless the renovation constituted at least 20% of the plant's replacement cost. Moreover, it would be up to the companies (coal -burning utilities, refineries and other industrial facilities) to decide if that requirement was met. Some 14 states, led by New York, have brought suit against the Bush Administration to stop the implementation of the new regulation on

the grounds that it effectively guts the Clean Air Act [Scott Richards and Yvette Hurt, USA: States sue the federal environment agency, *Federations*, 3(4) 2003].

In June 1997, President Clinton approved new tougher standards for air pollutants such as ozone and fine particulates. The standards, which will save thousands of lives each year, were proposed by the Environmental Protection Agency in November of 1996, when immediately, the auto, steel, chemical, and utility industries quickly mounted a multi-million dollar public relations blitz against them. The customary response of industry to such initiatives is to the bemoan the putative excessive costs of new regulations. When the regulations aimed at reducing sulphur dioxide and ozone were proposed the same reactionary outcry was heard, yet the cost proved to be considerably lower than the hyperbolic claims made by industry. The reason for this commonly observed result is know as "regulatory forcing." Corporations either deliberately exaggerate expected compliance costs, or simply extrapolate from existing technologies. Yet, when force to comply with more stringent regulations, corporations usually find more cost-effective ways to reduce pollution. It would be better, in their view, not to have to meet a higher standard, but once forced to do so, they do so efficiently.

Many existing Clean Air Act programs, such as the control program, and the ground level ozone smog programs, if properly implemented, will do much to reduce concentrations of fine particles by controlling the precursor pollutants. Reductions in sulfur dioxide, the largest contributor to fine particle pollution in the East, have proven to be far less expensive than anticipated. The price of sulfur dioxide emissions allowances, a very good indicator of the cost of emissions reduction, has fallen to $68 per ton, compared to the $300 to $750 per ton predicted when the Clean Air Act Amendments were passed. Clearly any program to reduce pollution will be costly, but it will also produce benefits. What matters is the balance between the benefits and the costs. Industry opposes such regulations because it expects to bear some of the costs on the bottom line, but will get none of the benefits.

Emissions trading

Emission trading has developed in an incremental way in the United States. Beginning in 1976 firms were allowed to build new plants only if they paid for the reduction of emissions of the seven controlled pollutants in other plants in the region (there are 247 regions). To do this, the firms had to buy "Emission Reduction Credits" from a firm that had reduced emissions below the state requirement. In 1979, firms were allowed to group plants and treat them "as if" they were under a "bubble." Under this policy, individual plant emissions did not matter. The only requirement was that the firms held to constant emissions under the bubble. If effect, firms could now "trade" emissions among its various plants. Firms could now choose where and how to most cost effectively reduce emissions rather than having to met some standard for every plant. It has been estimated that having such flexibility saved firms at least $10 billion and probably much more [Sorrel & Skea, *Pollution for Sale,* p. 5]. As most of the actual exchanges

have been withing individual firms, there has been little in the way of purchases of ERCs [Sorrel & Skea, *Pollution for Sale,* p. 5]. The purchase of ERCs was inhibited by the lack of a visible market to bring buyers and seller together, and some concern about the legal status of an ERC [Sorrel & Skea, *Pollution for Sale,* p. 5].

Even more flexibility was attained with the implementation, in 1995, of the Acid Rain Program. This program greatly expanded the bubble and established a market for permits with a definitive legal standing. This program allows any power station in the United States to trade sulphur-dioxide emissions with any other power station in the contiguous United States. As similar plan in California allows some 400 of the larger plants in the region to trade emissions of sulphur-dioxide and the various nitrogen oxides. A similar plan for nitrogen oxides is under development for the eight northeastern states.

The goal of the Acid Rain Program was to reduce sulphur dioxide emissions from US power stations by 50%. In Phase I (1995-2000), the 110 largest power stations were required to reduce emissions by 3.6 million tons/yr. In Phase II, 800 power plants will be required to cut emissions by a further 5 million tons/yr. From 2000 on, total emissions are capped at 8.95 million tons/yr [Sorrel & Skea, *Pollution for Sale,* p. 6].

The results of the program have been surprisingly good. By the year 2000, emissions had been cut by 3.4 million tons more than required by the 1995 standard. The unused permits are being "banked" to be used in Phase II. The price of allowances has fluctuated some, but as of 1999, they are selling for about $90 per ton which is far below the skeptical projections of the program's opponents.

Emissions have been reduced through the use of flue-gas desulphurization and switching to low-sulphur coal. The latter was promoted by a serendipitous decline in transportation costs following from deregulation of the railroads [Sorrel & Skea, *Pollution for Sale,* p. 6]. It is estimated that the flexibility allowed by the saleable permit system has reduced the cost of meeting the 1995 emission standard by about 45% [Sorrel & Skea, *Pollution for Sale,* p. 6].

The "tradeable permit" scheme is preferred over a "Pigouvian tax" for several reasons. First, once a standard is established, it is not obvious what tax should be implemented to reach it. Given how little is known, a priori, about the actual costs of meeting the standard, it is impossible to predict how the marginal cost of abatement will compare with the tax. If the tax is set too high firms will spend more than is necessary to meet the standard (as they will surpass it). If the tax is set to low, too little will be done. Hence, there will have to be a constant tinkering with the tax rate which will be both annoying, and costly as it will produce uncertainty.

Second, there is the problem of draining liquidity out of firms and then the political problem of what to do with the revenue proceeds. In Sweden, proceeds from its "green taxes" were used to reduce income taxes. Many American economists have urged such a use for any such tax revenues produced in the US. Nevertheless, as the current debate (2000) about how to spend the "surplus" indicates, not a little rancor will be produced on this issue.

Flexibility or just good luck -Contingency can be serendipitous

Railroad deregulation following the Staggers Act (1980) led to a reduction in freight rates such that the cost of transporting low sulphur coal from mines in Wyoming fell about 35% . Consequently the use of low sulphur coal by electric utilities in the Ohio Valley just about

doubled [Richard Kerr, Acid Rain Control: Success on the Cheap, Science]. An earlier version of Clean Air Act attempted to mandate the use of low sulphur coal, but a coalition of Eastern coal mining unions, the mine interests in Kentucky and West Va., and Ohio Valley Utilities prevented it - all for obvious reasons. But when RR transportation costs unexpectedly fell, the utilities switched to low-sulphur coal to meet new standards. Thus, it was surely the flexibility allowed by the "market-based permit system" and very good luck explains the low cost of controlling acid rain. Moreover, "scrubbers" turned out to be cheaper (by some 40%) than thought (new instrumentation and controls reduced labor needs) [Kerr, Science]. Of course, the benefit of cheaper scrubbers would have obtained should the EPA have made scrubbers mandatory. But the Act of 1977 made scrubbers mandatory only on new capacity be it manifest in a new plant, or one significantly modified to produce more electricity. In either case, the utility had to go through a "New Source Review" to insure it would meet the 1977 standards.

Since1977 no plant has applied for "approval for renovations of expansions" even though it was evident that many had modernized existing facilities to expand production capacity. Indeed, 51 plants had expanded without approval -cost avoided $5 billion Accordingly, Clinton's EPA brought suit to force the firms to comply with the Clean Air Act.

The industry responded with an increased lobbying effort and political contributions. The Edison Electric Institute, the primary industry lobbying group was led by Thomas Kuhn (a Yale Classmate of Bush, a big Republican giver) focused on the issue. Others took even more aggressive action. Electric Reliability Coordinating Council gave 10 million to political campaigns since 2001 with 75% of the funds going to Republicans. The lobbying effort and the contribution efforts were focused on rewriting the rules on new source review in favor of the industry. When elected Bush/ Cheney formed the Cheney Energy Task Force and packed with energy interests who proceeded to reformulate the nation's energy policy including new source review.

Bush chose regulatory revision over congressional debate. Rather than ask Congress to modify the Clean Air Act, Bush canceled the EPA suits and established "new rules." Under Bush's rule, plants must add pollution controls only if they add 20% or more to capacity. Needless to say, under this standard not one company need apply for new source review.

At present (2004), 14 states are suing the EPA to force it to enforce the Clean Air Act. But so far at least, in the Bush Administration Energy Policy has trumped Environmental policy. Had not the costs of low sulphur coal and "scrubbers" fallen serendipitously, one wonders whether the acid rain control program would have worked at all. It seems evident that the industry might have prevailed using lobbying, public relations and graft. But, then there was another serendipity, a conservative, radical, energy industry toadie was elected president.

Black Carbon - the "bad actor"

Black carbon emissions ares the consequence of incomplete combustion of fossil fuels, biofuels and biomass [Surbai Menon, James Hansen, Larissa Nazarenko, and Yufeng Luo, Climate Effects of Black Carbon in China, Science, 297(27 Sept. 2002) p. 2250]. BC emissions are particularly large in China and India because millions of households burn biofuels and coal at

low temperatures [Menon et al, p. 2250]. Unlike most aerosols, black (elemental) carbon[13] absorbs rather than reflects sunlight and heats the air. Two NASA scientists have asserted that "soot" (BC) may be responsible for as much as half of all global warming. In an article in *Science*, they report that BC is affecting the weather in China and probably India - producing periods of drought in both countries. Black carbon they say, is a "particularly bad actor" [Manon et al, p. 2252].

In China, the BC aerosols have the effect of local cooling by blocking solar radiation, but at the same time they contribute warming the rest of the globe by absorbing solar radiation and exporting the heat to the rest of the world [Menon et al, p. 2250]. Menon et al claim that the impact of this local cooling on convection currents has changed the pattern of precipitation so that Northern China gets more drought and Southern China gets more rain and floods.

Moreover, it has been reported that BC aerosols are "carcinogenic and are major cause of deaths associated with particulate pollution"[Menon et al, p . 2252].

Hence, reducing black carbon emissions will produce health benefits in the form of reduced PM, reduce climate forcing in atmosphere, and stabilize the climate in China.

The sources of black carbon are many and diverse. Most obviously the burning of fossil fuels produce black carbon emissions, but the quantity is surprisingly very small compared to other types of burning - wood for example. The residential burning of wood for heat produces more than three times the amount of BC than does burning coal. "Prescribed forest burning" produces over four times as much black carbon as coal burning and twice as much as "wildfires."

One way emissions of many greenhouse gasses, especially CO2, can be reduced is to improve the mileage of the global auto fleet. One way to do this is the convert to diesel engines. In Europe, 40% of new cars are powered by diesel engines, and diesel engines are an important part of the path toward lower ghg emissions. Unfortunately, diesel engines, both "onroad" and "offroad" appear to be a major source of BC emissions. Of course, filters can be used to reduce the BC emissions, but they reduce the mileage advantage of diesel engines.

Indoor Air Pollution

Perhaps the most dangerous form of indoor air pollution is secondhand smoke from cigarettes. In 2006 , California declared secondhand smoke to be a "toxic air pollutant." This action was based on a report by scientists at the state's Office of Environmental Health Hazard Assessment which drew on more than 1,000 studies of the effects of secondhand smoke. The scientists calculated that secondhand smoke caused some 4,000 deaths each year in California from lung cancer or heart disease. The study also reported that young women exposed to secondhand smoke increased their risk of developing breast cancer by as much as 120 percent.

The report also linked secondhand smoke to premature births, asthma, heart disease, and

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[13] Charcoal and soot are generic terms for complex organic molecules. Scientists refer to them with the general term "black carbon." Some have speculated that much of the carbon that is missing from the atmosphere is in the soil in the form of black carbon. Recall, the burning of fossil fuels releases CO2 into the atmosphere, but less is found there than would be expected (missing carbon sink). Researchers at the University of Zurich hypothesize that the missing carbon is in terrestrial ecosystems in the form of charcoal (charred trees) and soot that has returned to earth.

to other cancers and health problems in children. The ruling puts environmental tobacco smoke in the same air pollution category as diesel exhaust, arsenic and benzene [*Associated Press*, Jan 26, 2006]

A newer form of air pollution is the result of new construction methods that make homes and offices airtight (to conserve energy). The lack of circulation allows the build-up of toxic gases and, in some cases, radon. These may be more harmful than smoke emitted from exhaust pipes and smokestacks. The single most toxic threat to indoor air quality is tobacco smoke. In homes where there are smokers, particulate matter can reach 700 micrograms per cubic meter which is quite in excess of the ambient standard of 50 set by the EPA [Nadavukaren, p.508]. Smokers also emit carbon monoxide and benzene, the latter a known carcinogen. Indeed, smoking is the primary source of human exposure to benzene[14] [Nadavukaren, p. 508].

Radon is emitted as uranium decays. Thus, it is radioactive and emits dangerous alpha particles as it decays. These particles enter the lungs and can damage tissues causing lung cancer. At present, radon is considered the second leading cause of lung cancer, second only to smoking cigarettes [Nadavukaren, p. 505]. Certain rocks such as granite and shale can produce enough radon to pose a health hazard in a confined space. In open air the radon is diluted to harmless concentrations, but in a modern, weather-tight building it can accumulate to dangerous concentrations. In one extreme case, a radon exposure equivalent to 455,000 chest x-rays per year was found [Nadavukaren, p. 503]. One day, when the family patriarch went to work at a nuclear power plant, he set off the radiation detection alarm. In some areas where concentrations are high, residents get the same exposure to radiation as the people of Chernobyl following the nuclear melt down in 1986 [Nadavukaren, p. 505]. When radon exposure is combined with cigarette smoke, the health hazard increases by a factor of 10 [Nadavukaren, p. 505]. At present, the EPA estimates that about 1 in 15 American homes have radon exposures above the standard of 4 picocuries per liter of air. The average indoor level is 1.3 compared to outdoor levels of .4. But, any exposure to radiation involves risk. The EPA recommends remediation when radon readings exceed 4 pc/L.

EPA studies of human exposure to air pollutants indicate that indoor air levels of many pollutants may be 2-5 times, and occasion more than 100 times, higher than outdoor levels. These levels of indoor air pollutants are of particular concern because it is estimated that most people spend as much as 90% of their time indoors [EPA].

A new phenomenon, know as "sick building syndrome" has been an increasingly common observation since the 1970s. In such buildings the occupants experience various types of acute discomfort ranging from eye irritation to headaches, to itchy skin to nausea and dizziness, yet no single provocative agent can be found [Nadavukaren p. 515]. World-wide, the WHO has estimated that as much as 30% of the world's "new and newly remodeled buildings may be generating complaints" [Nadavukaren, p. 515]. In some cases, the causes have been found. The culprits have been synthetic mineral fibers from ceilings, ozone from copy machines, micro-organisms spreading thorough ventilation systems, and auto-exhaust fumes entering ventilation systems, to mention a few [Nadavukaren, p. 515].

A study published in 2003 in the medical journal Lancet provided convincing evidence

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[14] A person exposed to cigarette smoke is exposed to five times more benzene than a worker in the vicinity of a coke oven - the largest industrial exposure [Nadavukaren p. 509].

of the extent to which microbes were responsible for "sick buildings." Researchers at McGill University presumed that to the extent that microbes and fungi were responsible for Sick building syndrome, irradiating air conditioning systems with UV light should diminish the problem. Using a building that had two air conditioning systems each serving a different part of the building, the researchers set one as a "control" and applied UV light to the other. The researchers found a 99% reduction of bacteria, fungi and endotoxins (irritants produced by mold) in the treated system. Moreover, the workers in the space served by the treated systems reported a 20% reduction in sick-building symptoms [*Providence Journal*, 11/28/03].

Of course, as noted above there are many other irritants than are circulated by air-conditioning systems, most especially various chemical air pollutants.

The symptoms people exhibit in many cases may also reflect something newly named as "multiple chemical sensitivity" which is sometimes called the "20th Century Disease." [Nadavukaren, p. 513]. While many substances circulating in the air of closed buildings may have no individual effects on health, acting synergistically, they may have profoundly serious effects on some individuals, even at low levels of exposure.

The following was published in Rachel's Environmental Newsletter 2/12/98 and was written by Peter Montague.

In various large surveys 15% to 30% of Americans (37 to 75 million people) report that they are unusually sensitive or allergic to certain common chemicals such as detergents, perfumes, solvents, pesticides, pharmaceuticals, foods, or even the smell of dry-cleaned clothes. An estimated 5% (13 million people) have been diagnosed by a physician as being especially sensitive. Many of these people react so strongly that they can become disabled from very low exposures to common substances. Typical symptoms include prolonged fatigue, memory difficulties, dizziness, lightheadedness, difficulty concentrating, depression, feeling spacey or groggy, loss of motivation, feeling tense or nervous, shortness of breath, irritability, muscle aches, joint pain, headaches, head fullness or pressure, chest pains, difficulty focusing eyes, nausea, and more. This group of symptoms is known as environmental illness or, more commonly, multiple chemical sensitivity (MCS), meaning "sensitivity to many chemicals."

MCS has been recognized by its symptoms for 50 years because MCS sufferers in many geographical areas, researchers studying them, and doctors treating them, have reported a remarkably consistent picture of disease. However, because MCS sufferers react to chemicals at levels that are hundreds or thousands of times lower than allowable occupational exposures, traditional toxicology dictates that their symptoms cannot be caused by chemical exposures. Nor is MCS a true allergy because there are no IgE-mediated reactions involved, so allergists don't know what to make of it. In sum, because MCS does not fit any of the three currently-accepted mechanisms of disease --infectious, immune system, or cancer --traditional medicine has not known how to explain MCS, and so has often labeled it "psychogenic" --originating in the patient's mind. This has left MCS sufferers in limbo. Told they are crazy, or imagining their disease, or making it up, they find themselves passed from physician to physician without any satisfactory answers and often without relief from their very real distress. (Some MCS sufferers DO have psychological symptoms, but that doesn't necessarily mean their disease ORIGINATES in their mind.) Forty percent of MCS sufferers report having seen more than 10 medical practitioners.

MCS came to the attention of mainstream science and medicine forcibly in 1987 when U.S. EPA (Environmental Protection Agency) installed 27,000 square yards of new carpeting and painted and remodeled office space at its Waterside Mall headquarters in Washington, D.C. Some 200 agency employees developed symptoms associated with "sick building syndrome --and several dozen EPA employees later reported developing MCS. The National Research Council has now accepted that "sick building syndrome" is a real phenomenon, producing MCS-like symptoms.

Most recently, MCS has been in the news because there are two new, large populations of people who exhibit some or all of the symptoms of MCS: Gulf War veterans, and women with silicone breast implants. Since 1990, progress has been made defining and understanding MCS, though there is still a long way to go. Nevertheless, real progress has been made. A new book --a second, updated edition of CHEMICAL EXPOSURES; LOW LEVELS AND HIGH STAKES, by Nicholas A. Ashford and Claudia S. Miller --offers a lucid, thoughtful description of the current science and medicine of MCS, suggests a hypothesis (which could be tested) about the origins of the disease(es), and offers real hope to sufferers that one day their ailments will be understood and treated, possibly even prevented. The stakes are enormous, and the chemical industry knows it. If a clearly-defined disease emerges from research on MCS, with chemical causes that are understood, then it can't be too many decades before chemical corporations will have to face liability and compensation claims from millions of victims harmed by their products. Who knows where this might lead in the relationship between corporations and an angry public?

Like the tobacco companies before them, the chemical corporations are bent on casting doubt on the serious medical research now being conducted to discover the causes and physiologic mechanisms of MCS. The chemical corporations have labeled such research "junk science," and they have funded a new research arm of their own (modeled on the Tobacco Research Institute?) called the Environmental Sensitivities Research Institute (ESRI). Monsanto, Procter and Gamble, the Cosmetic Toiletries and Fragrances Association, and other companies and trade associations involved in the manufacture of pharmaceuticals, pesticides, and other chemicals, each pay $10,000 per year to keep ESRI going. The head of ESRI is Dr. Ronald Gots, who also runs something called the National Medical Advisory Group, which provides expert witnesses to defend the chemical corporations in tort lawsuits. Dr. Gots has published no original peer-reviewed research on MCS, yet he and ESRI specialize in claiming that MCS is a mental disorder. Dr. Gots says, "[E]verything that is known about MCS to date strongly suggests behavioral and psychogenic explanations for symptoms." In other words, if you exhibit some or all of the symptoms of MCS, you are probably crazy and if your doctor thinks otherwise, he or she is probably a charlatan. Such a claim has special staying power because it cannot tested scientifically. As long as anyone is around to assert its validity, such a claim surrounds MCS research with an aura of controversy --and controversial topics have trouble attracting mainstream funding.

Here is a typical "advertorial" by ESRI from the February, 1996 issue of THE MERCHANDISER (Spring Grove, Pennsylvania):

"Multiple Chemical Sensitivities: Fear of Risk or Fact of Life?

"Scientists are increasingly concerned that a doubtful new diagnosis--supposedly

caused by everything 'man-made' in the environment--is unnecessarily making thousands of Americans miserable each year. One of these so-called 'modern diseases' is called MCS, for Multiple Chemical Sensitivities. Many established scientists and physicians doubt MCS actually doesexist; it exists only because a patient believes it does and because a doctor validates that belief. For information on MCS, write the Environmental Sensitivities Research Institute, 6001 Montrose Road, Suite 400, North Bethesda, MD 20852."

The authors of the new book on MCS are highly qualified. Nicholas Ashford is professor of technology and policy at Massachusetts Institute of Technology (MIT) with advanced degrees in chemistry and law. Claudia Miller is a medical doctor with a Masters degree in environmental health; she teaches at the University of Texas Health Science Center in San Antonio. Their 1989 report on MCS, funded by the New Jersey Department of Health, won the prestigious Macedo award of the American Association for World Health. Their new book is a pleasure to read. It is clear, thoughtful, intelligent, and carefully written. It makes an important contribution to our understanding of chemical sensitivity.

In reviewing several hundred studies --not all of them of good quality --Ashford and Miller describe the common themes that emerge from the good ones: MCS seems to be a disease (or family of diseases) that occurs in two stages. MCS is "initiated" by a high exposure (for example, a chemical fire, or spill) or by repeated moderate exposure to pesticides or solvents or some other strong chemical(s) such as those found in chemical dumps or used in remodeling homes or offices, including new carpeting.

After the "initiating" exposure, symptoms are then "triggered" by extremely low exposure to many different chemicals, such as those found in fragrances, or tobacco smoke, pharmaceuticals, or foods. Not everyone exposed to chemicals gets MCS, just as not everyone stung by a bee goes into anaphylactic shock. A certain portion of the population seems predisposed to react strongly to chemicals after an initiating event.

The mechanisms of MCS are not understood, but recent evidence suggests that the nervous system (or perhaps the nervous and immune systems together) somehow become sensitized by an initiating exposure. Thereafter, low exposures to common chemicals bring on major symptoms way out of proportion to the size of the stimulus. Ashford and Miller suggest that MCS is not really the best name for this ailment or family of ailments because it fails to reflect the importance of the initiating chemical exposure. They suggest that the name Toxicant-Induced Loss of Tolerance (TILT) better describes the true nature of the illness(es) --initiated by a toxic exposure which leads to the loss of tolerance for common chemicals. They suggest that different initiating events may give rise to somewhat different ailments, all of which cause sensitivity to chemicals --just as different infectious diseases can all cause a fever.

The scientific community has held several symposia on MCS (or TILT) since 1990 and a scientific consensus has been reached on the double-blinded, placebo-controlled research that needs to be conducted to define this disease (or disease family). Despite this consensus, the research is not being conducted because the needed facilities do not exist. A special "environmental medical unit" needs to be built, preferably in a hospital, to test MCS patients by

exposing them to chemicals under controlled conditions and observing their responses. Despite numerous recommendations that such a unit should be built --including a recommendation from the National Research Council--the funding is not there.

Without naming him, authors Ashford and Miller blame Ronald Gots and others like him for the logjam: "...those who continue to promote untested and untestable psychogenic theories for MCS are part of the problem. Their lobbying of policymakers and others in this regard has contributed to widespread governmental inertia on this issue, making it near impossible to obtain funding for essential studies specifically directed toward MCS. Many of those who advocate psychological explanations in government-sponsored meetings and in the scientific literature are paid corporate spokespersons or consultants with financial conflicts of interest. Yet these conflicts generally are not revealed when these individuals appear in scientific meetings, author scientific articles, serve on official panels or boards, or serve as reviewers of grant proposals. Policymakers and publishers of scholarly journals need to recognize and remedy this appalling injustice."

These are not academic questions. Seventy thousand Gulf War veterans, alone, have sought help. They are told they must prove their disease exists --but without research they have no proof. The same is true of tens of thousands of women whose breast implants have left them with many of the symptoms of MCS. (David Kessler, when he was head of the Food and Drug Administration (FDA) said, "We know more about the life of a tire than a breast implant.") These and millions of other people are genuinely suffering, yet they are told --with no research basis --that there is nothing medically wrong with them--it's all in their minds. Only research can find the truth.

Quite possibly, MCS or TILT is a new, fourth disease mechanism parallel to infections, immune disorders, and cancer. Those suffering its symptoms cannot gain relief from their torment until the needed research is done. Those who are being paid by chemical corporations to stand in the way of that research deserve the labels inhuman and inhumane. Would criminal be too strong a word? End of Rachel excerpt.

The "Mother of All Problems"[15] - Global Warming and Climate Change

The scientific evidence on global warming is now beyond doubt. Readers of these pages during the past couple of years have seen one careful study after another documenting the role of anthropogenic sources of carbon dioxide and other greenhouse gasses in global warming; describing the impact of past and present climate change on marine and terrestrial ecosystems; and measuring rates of glacial melting in the Arctic, the Antarctic, and the tops of low-latitude mountains [Donald Kennedy, editor*, Science,* 299 (17 January 2003, p. 309].

In March of 2002, scientists were astounded when the Larsen B Ice Shelf, a floating ice mass in Antarctica about the size of Rhode Island, disintegrated. The Larsen B shelf, which was

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[15] William D Nordhaus [1998] Assessing the Economics of Climate Change: An Introduction, Chapter 1 in Economic and Policy Issues in Climate Change, William D. Nordhaus ed., Resources for the Future p. 9.

18,000 years old, disintegrated over only a two-month period. According to geologist Prof. Eugene Domack, having witnessed this event, "bells should be ringing, in terms of global warming, in Washington, D.C. *[*Gerald Carbone, Seas Will Rise, New Orleans May be Doomed*, Providence Journal,* April 7, 2002*]*. This profoundly disturbing event is only one of many "canary calls" that should have been setting of bells in Washington for some time.

The "headlines from the planet," according to Boston Globe journalist Ross Gelbspan, leave little doubt that the Earth is warming and that nothing short of catastrophe portends. What follows is a short-list of some of these worrisome observations.

- Over the past twenty years the population of zooplankton of the coast of southern California has declined by 70%. The result is a "vast wasteland" virtually devoid of fish, most notably the anchovy, and birds. The culprit is a 2-3F increase in surface water temperature over the past 40 years [Gelbspan p. 136].
- New Orleans is being ravaged by the Formosan termite. Trees along the scenic St. Charles St. trolley line, are literally falling over having been consumed from the inside out by termites. In the absence of a killing frost for the past five years, the termite population has exploded [195-96].
- Rising water temperatures in Monterey Bay have produced the out-migration of the cold water crabs, starfish, algae, snails and may other species, and an in-migration of warm water species [137].
- Glaciers all over the world are in retreat. In the Alps, over the last century, small glaciers have lost about 10% of their and the larger ones some 50% of their mass. Whether one looks at the Peruvian Andes, the Tibetan Plateau or Indonesia, the observation is the same, the glaciers are retreating with alarming speed [p. 139].
- The growth rate of trees in the Alaskan boreal forest has flattened out. Initially, due to warming and increased levels of carbon-dioxide, tree growth accelerated, but now it appears that warming is "stressing the forests." As warming both increases moisture loss and promotes the propagation of insects, it appears to being doing more harm than good for the boreal forests. Several million acres of forest were recently lost to bark beetle, which in the warmer clime has shortened its reproductive cycle from two years to just one [p. 141].
- In Alaska soil temperatures have risen from 2-5C over the past century. The deep layer of the Arctic ocean has warmed 1C in just the last few years. NOAA reports that surface temperatures at the Arctic Circle have risen by about 5.5C (9.9F) since 1968 [p. 143].
- The El Niño Southern Oscillation (ENSO) has radically departed from its traditional patterns. In the past, the El Niño alternated with La Niña over a four year cycle. When El Niño is "on," warm waters for the western Pacific, usually kept there by prevailing westerly winds, flow eastward toward the west coast of the Americas. These warm waters produce a great deal of moisture through evaporation and, with the help of jet stream, heavy rains in the Americas, most especially in the central and southwestern United States. The El Niño that ended in 1995, was the longest on record, and it produced the massive flooding of the Mississippi that devastated the mid-west in that year. This particular El Niño lasted nearly six years, a duration, according to climate scientists that

can be expected only once every 2000 years. Indeed, since the late 1970s, there has been a discernable patterns of more and longer El Niños and fewer La Niñas [p. 143].

- Each year as spring ensues and plant life proliferates, the carbon dioxide loading in the atmosphere declines. In fall and winter when plants die and decompose the carbon dioxide loading rises again. It appears that in the Northern Hemisphere at least, spring is coming earlier now. The spring decline in carbon dioxide now comes a full seven days earlier than it did in the 1970s [p. 146].
- The surface temperatures in the Antarctic Peninsula have risen by 4-5F over the last 50 years - some five times more than the average rise in global temperatures. As a consequence coastal ice shelves are fracturing and falling into the sea [p. 146].
- Diseases such as cholera, malaria, dengue fever, hantavirus and some forms of encephalitis are moving into latitudes and elevations where they have been previously unknown and are becoming more prevalent in areas where they have always been. A cholera outbreak in Peru, that then spread as far south as Chile and northward into Mexico, infected one million people and took 5,000 lives in 1991-95 [p. 149]. Worldwide the incidence of hemorrhagic dengue fever quadrupled between 1986 and 1990 to 450,000 cases [p. 149].

I'm convinced if we don't stop global warming and stop the emission of carbon dioxide, we're going to completely mess up this Earth. Cities are going to be put out of business, cultures are going to be put out of business...We've got to speak out, we have got to let the public know what is going on. - Jonathan Overpeck, director of the Institute for Study of Planet Earth, The University of Arizona

The Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) released in April of 2001, noted that 1998 was the hottest year in the past millennium. Over past century the average global temperature has been increasing since 1861 and increased by .6C in the past century. Over the sea, the temperature increase has been about one-half of that observed over land. Overnight low temperatures have risen by about .2C per decade since 1950 thereby lengthening the growing season (the period between frosts) in the northern latitudes. The warming has led to a "widespread retreat" of mountain glaciers, a decline of about 10% in the snow cover (since 1960), a decline of about two weeks in the annual duration of river ice cover, a decline of 40% in arctic ice thickness in late summer, and an increase in sea level of as much as .2 meters during the 20th century.

The IPCC also reports and increase in global precipitation by about .5% to 1% per decade over the 20th century in the upper latitudes of the Northern Hemisphere and about .2% to .3% increase in the tropical latitudes (10N-10S). However, the report notes a decline in precipitation in the sub-tropical latitudes of the Northern Hemisphere (10N-30N). In the mid-to high Northern latitudes there has been a 2%-4% increase in the frequency of "heavy precipitation events" and a small increase in the "frequency and intensity of droughts," particularly in Asia and Africa.

The Group II Report, also issued in April 2001, studied, "Impacts, Adaptation and Vulnerability." Group II projects, the warming trend will continue and by 2100 global temperatures may rise another 1.4C to 5.8C and projects a sea level rise of .09 to .88 meters. Of

course, any projected impacts will depend on the realized temperature change. The consequences reported below are for the lower and mid-range temperature increase, because, " the available literature has not investigated climate change impacts, adaptation and vulnerability associated with the upper end of the projected range of warming." The report claims that likelihood of "future large-scale and possibly irreversible changes in Earth systems[16] " is not well-known, but is probably very low"[Group II, Summary, p. 6] In short, contrary to the pronouncements of many skeptics, this report is not an "alarmist" apocalyptic, worse case scenario based purely on speculation.

- A general reduction in potential crop yields in most tropical and sub-tropical regions and most regions in the mid-latitudes. While increased CO_2 concentration can increase crop yields, the gain is more often than not, offset by the adverse effects of heat and drought [GII(2001), Summary, p. 9]. It is also noted that the salutary effect of CO_2, that have been projected on the basis of laboratory experiments have not been realized "in the field."[p. 11].
- Decreased water availability for populations in water-scarce regions, particularly the sub-tropics. The number of people exposed to water stress is projected to rise form 1.7 billion to about 5 billion by 2025.
- An increase in the number of people exposed to vector-borne diseases and water-borne diseases and an increase in heat stress mortality
- A widespread increase in the risk of flooding from both increased heavy precipitation events and sea level rise. Heavy precipitation events produce in addition to floods, increased soil erosion, landslides, avalanches and mudslides. Flooding also would increase the risk of drowning, diarrhoeal and respiratory disease, and hunger and malnutrition in the developing nations [p. 12]
- Increased energy demand for cooling due to higher summer temperatures
- Increased intensity of mid-latitude storms and cyclone peak wind intensity which will increase coastal erosion and damage coastal ecosystems such as coral reefs and mangroves, and of course, increase damage to property and coastal infrastructure.
- The effects of climate change are expected to be the greatest in developing countries in terms of loss of life and economic effects

On the positive side, warming may produce some benefits

- Increased potential crop yields in some regions at mid-latitudes if temperature increase remains in the low range
- A potential increase in global timber supply from appropriately managed forests
- Increased water availability in some water-scarce regions such as Southeast Asia. Increased flood run-off could recharge some flood plain aquifers.

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[16]Here they refer to changes in the oceanic thermohaline circulation, the melting of the West Antarctic or Greenland ice sheet, carbon dioxide release due to the melting of the permafrost, or the release of methane from hydrates in coastal sediments. This type of event will be discussed later on in this chapter.

- Reduce winter mortality in the mid-and high latitudes.
- Reduced energy demand for space heating due to warmer winter temperatures

In 2002, the Bush Administration produced a document titled, U.S. Climate Action Report. Before the publication of this report, the Bush Administration had insisted that the science on global warming was inconclusive, and it was not evident that human activities had caused global temperatures to rise. The report not only accepts global warming as a "fact," it also agrees that human activity has been responsible [Andrew Revkin, Climate Changing, says U.S. report, *New York Times*, 6/3/02] . While surely many Republican friends of Bush, the energy and automobile industries for example, will view this report as apostasy, it is nonetheless, far from a progressive document. Indeed, the report contends that due to the accumulation of carbon dioxide and other greenhouse gasses already present in the atmosphere as a consequence of past anthropogenic emissions, there is little that policymakers could do to avoid substantial climate change over the next few decades. The report recommends that rather than substantially reducing future emissions of greenhouse gasses, the nation and the world merely accept them as inevitable and adapt to them.

Critics of the global warming hypothesis have used the fact that there existed a discrepancy between temperatures measured on the surface and temperatures of the lower troposphere (bottom five miles of the atmosphere) as measured by NOAA weather satellites. Data from the nine satellites, when averaged globally, showed no trend in atmospheric temperature. In 2003, however, climate researchers discovered the "anomaly" was the result of an adjustment to the data in light of a switch to a new, improved satellite in the mid-1980s. With the correction error removed, the satellite data are now in closer conformance with the surface data, and also with what computer projections based on climate models had projected. A gap remains, but it is smaller, but nevertheless points toward warming [Andrew Revkin, New View of Data Supports Human Link to Global Warming, *New York Times*, 11/18/2003]

While the report points to substantial ecological damage from warming, especially to highland meadows and coastal areas, it also emphasizes the potential benefits of warming such as increased agricultural output and forest growth due to longer growing seasons and more rainfall [Revkin, 2002]. "The only question," the report concludes, "is whether we adapt poorly or well" [Revkin, 2002].

The Bush Report presumes then that further accumulations of greenhouse gasses are of no consequence. Such is not the case. According to the Stockholm Environment Institute some climate change due to the current carbon loading of the atmosphere is "unavoidable." Moreover, while there may be some "safe rate" of climate change that would allow ecosystems to adapt [.1 degree centigrade], once global temperatures exceed preindustrial levels by 1-2 degrees centigrade we are going to observe "rapid, unpredictable, and nonlinear responses that could lead to extensive ecosystem damage" [New Scientist, October 20, 1990]. Indeed, the current carbon dioxide load of nearly 400ppm, is on the cusp of the range [400-650ppm] that the Institute considers likely to cause "grave damage" including the "complete destruction of Island nations [New Scientist, October 20, 1990].

At about the same time this report was published, the *New York Times* reported that Alaska was melting. As a consequence of a seven degree rise in average temperature [ten

degrees in winter, five degrees in summer] over the past 30 years, Alaska's permafrost is beginning to melt. Among the consequences, of a "landscape that can sink, catch fire or break apart ...are sagging roads, crumbling villages, dead forests, catastrophic fires, and the disruption of marine wildlife" [Timothy Egan, Alaska, No longer so Frigid, Starts to Crack, Burn and Sag, *New York Times*, 6/18/02]. In addition, it will surely cost millions to shore up the transAlaska oil pipe line.

All of these events and consequences are thought to be the result of global warming which, in turn, is believed to be the product if the rising concentration of greenhouse gasses in the atmosphere, the latter being the result of human activities - the burning of fossil fuels, the destruction of carbon sinks such as forests, and economic activities such as paddy farming, and so on. Yet, many wonder if these linkages are real. After all, the global climate is the product of many different and interactive forces, some biological, some chemical, some astronomical and some geological, and, of course, human activity, that operate on many different time scales. Some of these forces, notably the biological and the chemical, both determine and are determined by global temperatures, that is, they operate in complex positive and negative feedback systems. It is entirely possible that each system could be producing different tendencies for temperature movement at the same time. For example, the Malenkovitch astronomical cycles which are produced by variations in the orbit, wobble and tilt of the Earth as it moves around the sun, produce three cycles. At any point in time, all three may be producing a tendency for warming, or cooling, but more often than not they produce conflicting tendencies. The cycles operate on time scales of 400,000, 100,000, 41,000 and 23,000 years.

Some of these forces work on a longer time scale. For example, geological forces such a plate tectonics and continental drift operate on scales of millions of years. The climate of Antarctica has been shaped critically by the separation of Australia and the change ocean currents that followed. Similarly, as other continents drift oceans and wind currents change and climate change follows. The climate of the Indian sub-continent has been critically shaped by the continental collision the produced the Himalaya Mountains. We would not, however, expect to find evidence of these effects in data that covered the past 100 years or even the past 100,000 years or even a million years. Other geological forces operate on shorter time scales. The effects of volcanic eruptions are clearly revealed in annual temperature data. These eruptions produce effects that operate on different scales. As they expel sulphur-dioxide and a great deal of dust into the atmosphere, the immediate, but short-term effect of such eruptions is to cool the earth. The eruptions, however, are an important part of the carbon cycle, that is, they are the main geological process by which carbon, which has been sequestered in limestone by biological and chemical processes, is returned to the atmosphere where it tends to promote the greenhouse effect and warming over a longer time frame. Hence, over a longer scale these eruptions promote warmer temperatures.

Some of the more controversial processes involve biological entities. Living things from bacteria, to algae, to phytoplankton, to plants, to animals, to humans play an important role in determining the composition of the atmosphere and the amount of sunlight that strikes the earth. Living things are sinks for carbon, that is, as their population and as their activity increases they extract carbon from the atmosphere. In the case of phytoplankton, this carbon ends up on the

ocean floor as sediment. In some important cases, a great deal of plant life was buried in anaerobic environments so its carbon content did not return to the environment - it became coal. In short, plant life to the extent it sequesters carbon, has a cooling effect. Phytoplankton also produce a gas, dimethylsulphide (DMS) which reacts in the atmosphere to form aerosols of sulphuric acid which, in turn promote cloud formation, which also promotes cooling. So potent are these effects of life on climate, that some have given these processes the name Gaia - after the Greek Goddess of the Earth. Gaia asserts that rising temperatures set off negative feedback mechanisms, the biological processes just mentioned, that tend to cool it. Indeed, there is much evidence that over geological time (hundreds of millions of years), life has played an important, stabilizing role, that is, it has tended to prevent the earth from overheating like Venus. But, on shorter time scales, say the past several ice ages, the evidence suggests that life tends to amplify temperature changes that have been initiated say by the astronomical cycle.

On the time scale of the past century there has been detected an increase in average global temperatures of about .6C along with significant increases in the atmospheric loading of carbon dioxide and methane. While surely all of the biogeochemical and astronomical forces are at work, as they work on much longer time scales, it is unlikely they have produced this observation. The culprits, in this case is an animal, the human one. Over the past two centuries humans have been burning the coal that was buried during the Cretaceous period, a burial that was critical to preventing earth from overheating (see faint early sun paradox below) and, thus releasing the carbon dioxide back to the atmosphere and enhancing the greenhouse effect. Humans and their agricultural activities, notably livestock raising, are also responsible for increasing in the concentration in the atmosphere[17] of methane, a potent greenhouse gas,

Not all of the processes noted above are fully understood and surely not fully parameterized (e.g. we still can't account for all of the carbon in the world, nor can we pin-down the sensitivity of climate to carbon-dioxide concentrations), hence there is some uncertainty involved in forecasting climate change, and even explaining climate change. Nevertheless, given the short-time scale of our recent climate change, it is not unreasonable to conclude that we have met the enemy, and it is us. At least so concluded the IPCC Working Group I in a recent report on climate change. The group, in its April 2001 report, claims that there is now "new and stronger evidence that most of the warming observed over the past 50 years is attributable to human activites" [IPCC, Summary for Policymakers, p. 10]. In 1988, the Intergovernmental Panel on Climate Change (IPCC) was established to study the problem, and in 1992 the United Nations Conference on Environment and Economic Development was held in Rio de Janeiro. Known as the "Earth Summit," it produced many informal commitments to reduce emissions of greenhouse gasses, but to date, as a recent conference held to review the results of the Earth Summit indicated, no progress has been made.

In 1995, the IPCC reported that while the rise in global temperature is "unlikely to be entirely natural in origin,... the balance of the evidence suggests that there is a discernable human

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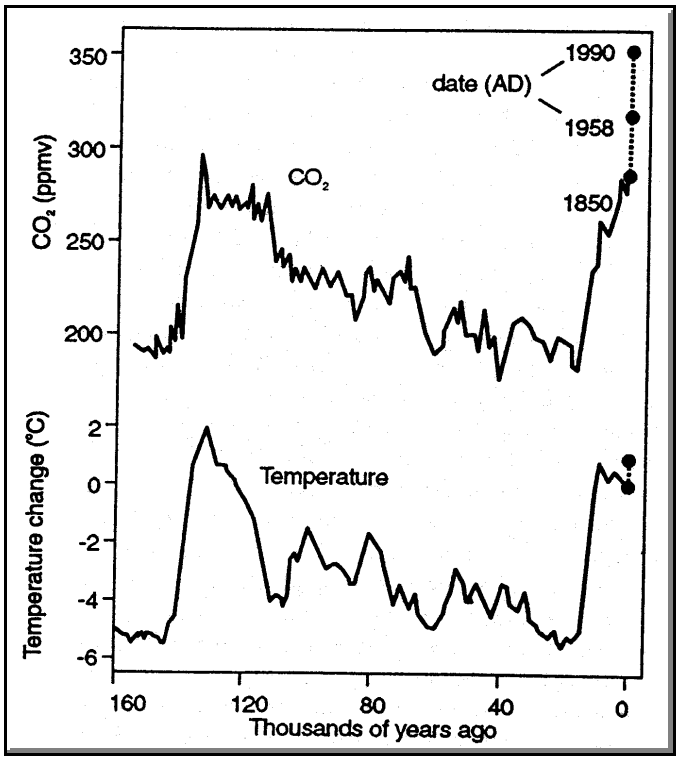
[17]About 80% of the methane in the atmosphere comes from biological processes. The majority of methane in produced in anoxic environments such as swamps and marshes and paddy fields by anaerobic bacteria who decompose organic materials. The remaining 20% is called "dead methane" because it comes from fossil sources that have lost all of their carbon 14. The source is primarily mining activities which cause methane trapped with coal deposits to be released into the air [E. Mazaros, Atmospheric Chemistry, p. 37].

influence of global climate." The magnitude of this influence, the panel reported, was "unknown because of 'uncertainties in key factors' including the degree to which clouds and the oceans effect the rate of temperature change." The IPCC indicated the need for policy measures to reduce emissions of greenhouse gasses by 20% below 1990 levels and to ultimately reduce emissions by 70% [Rampton & Stauber p. 268].

The IPCC report received contributions and peer-review from over 2,500 of the world's "statured" climate scientists, economists, and risk-analysis experts. " The IPCC believed it would take at least another ten years of research to solve these problems [N. Geo. 5/98 p. 44]. The IPCC[18] issued another report in 2001 that for the most part were similar to the second report which was issued in 1995, but did have several more years of data, including the hottest year on record 1998. Also it had benefitted from several more years of research on the role of aerosols, particularly the sulfates produced by burning coal, and was then more confident in its assertions.



There are about 750 billion tons of carbon dioxide in the Earth's atmosphere. Indeed, in 2001 the IPCC reported that "the present concentration of carbon-dioxide has not been exceeded during the past 420,000 years, and quite likely not during the past 20 million years [Summary p. 7]. The atmosphere, however, is still only about .035% carbon-dioxide. Scientists have measured the amount of CO_2 and found that it has increased by about 10% since 1957 about 31% since the 1750, that is, the beginning of the industrial revolution.[19] [Schneider, *Laboratory Earth*, p.75, IPCC G1, p. 7]. The evidence that these increases were anthropogenic is, according to climate expert Stephen Schneider, "overwhelming" [ibid p. 75]. Moreover, since the middle of the 19th century there has been an increase in the average global temperature of about .6 degrees C (.9F).

The IPCC reported in 2001 that about 3/4 of the anthropogenic emissions of CO_2 during

[18]In total the report was written by 122 Co-ordinating Lead authors and lead authors, 515 Contributing authors, 21 review editors and 337 expert reviewers [IPCC, Group I, Summary p. 2 n.2]

[19] The amount of CO_2 has been measured directly since 1957 at such remote places as Mauna Loa Observatory. The figures for the period since the Industrial Revolution are derived from ice cores taken from both poles [Schneider, Laboratory Earth, p. 75]

the past 20 years have been the consequence of burning fossil fuels[20], the rest was due to changes in land use, primarily deforestation [GI, p. 7].

Even a casual perusal of the graph to the left reveals a reasonably high correlation between the concentration of CO_2 and the change in global temperature over the past 160,000 years. Yet, climate dynamics are far too complex to be captured in such a simple correlation. Climate is produced by biogeochemical processes so complex that they have yet to be fully comprehended or modeled.

Although, scientists have understood, for at least a century, that anthropogenic emissions of carbon-dioxide will promote greenhouse warming of the earth, "for most of the twentieth century, the greenhouse effect was not considered a priority problem" [Cline p. 13]. World temperatures had cycled[21] in the first half of the century and scientists believed that any anthropogenic increases in carbon-dioxide would be absorbed by the oceans. Then, beginning in the late 1950s, scientific opinion began to shift. In 1957 a new study revealed that the oceans were not absorbing carbon-dioxide at sufficient rates to forestall warming. Based on this evidence, the authors of the study warned that "human beings are now carrying out a large-scale geophysical experiment" [quoted in Cline p. 14]. Concern about global warming intensified when it became known that the 1980s was the warmest decade on record and 1991 was the second hottest year ever recorded [Cline p. 28- 29]. The trend continued into the 1990s.[22] Most of the warming took place in the periods between 1910 and 1945, and 1976 and 2000 [IPCC, Group I Summary, p. 2]. Thirteen of the warmest years of the 20th century were recorded since 1980, the decade of the 1990s in the warmest decade of the century, and 1998 holds the distinction of the warmest year of the century [National Geographic 5/98 p. 48, IPCC, Summary Group I, p. 2]. Over the century the average global temperature rose by .6C which by historical standards is "unusually large and abrupt" [National Geographic 5/98 p.48]. Indeed, the IPCC report asserted that the "increase in temperature in the 20th century is likely to have been the largest of any century during the past 1,000 years. It is worth noting that in the "little Ice Age"[1570-1730] the global temperature dropped only .5C [National Geographic 5/98 p. 46].

Concern about global warming then escalated when it was discovered that other gasses such as methane and chlroflourocarbons (CFCs) were adding to the greenhouse effects of carbon-dioxide [Cline p. 14]. The concentration of methane has increased 151% since 1750, with about 50% of that increase being the result of human activity, and is now as high as it has been in the past 420,000 years [IPCC, G1, Summary, p. 7].

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[20] Fossil fuels include oil, coal and natural gas. Coal produces more carbon emission than either oil or natural gas. Coal releases 29% more carbon per unit of energy than oil, and 80% more than natural gas. Coal accounts for 43% of annual global carbon emissions (2.7 billion tons). The US relies on coal for 53% of its energy production [Worldwatch Institute, Phasing out coal, 8/25/99].

[21] The earth warmed from 1910 to 1940 and then cooled from 1940 to 1975. It warmed again through 1990 and continues to do so [Cline p. 27].

[22] Several years in the early 1990s were "cooled" by the aerosols shot into the stratosphere by the eruption of Mt. Pinotubo in 1991. These sulphate aerosols reflected sunlight back to space and drew heat from the earth. The result was virtually no summer in the northeastern US and a one degree overall drop in global temperatures [NYT 1/27/98]

The most serious potential dangers, produced as a by-product of the combustion of fossil fuels, and other human activities, are the so-called greenhouse gases. Carbon dioxide, CFCs, methane, ozone and nitrous oxide inhibit the diffusion of infrared solar radiation back into space thus causing the air temperature to rise[23].

The potential economic, and social disruptions, following from global warming are controversial and different for different parts of the world. The countries most susceptible to climate change are the undeveloped countries dependent on agriculture, forestry, outdoor recreation and coastal activities. For example, should sea levels[24] rise, much of Bangladesh's agricultural land will be submerged. Moreover, the intensification of storms expected with warming will add to the toll of 600,000 lives taken by cyclones in the past thirty years [Gelbspan p. 162]. It has been estimated that over the next fifty years storms and flooding could create 26 million refugees from Bangladesh alone [Gelbspan, p. 162].

Low-lying areas such as the Netherlands and Florida would be threatened. The EPA has estimated that the predicted sea level rise could inundate up to 60% of our coast wetlands (5,000 square miles or, an area about the size of Connecticut)[Gelbspan, 1999,p. 71]. If climate change should alter the variability, which is, at present, not inconsiderable, of the Indian monsoon, 600,000 villages in India will be unable to grow their food in some years and will be devastated by floods in others[25]. There is compelling circumstantial evidence that the advance of the Sahara

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[23] Solar radiation comes in short wavelengths (.2 to 4.0 micrometers). Outbound infrared radiation from the earth is longwave (4 to 100 micrometers). Clouds, water vapor and greenhouse gasses are "relatively transparent to shortwave radiation, but much more opaque to longwave." Consequently, about half of the sun's radiation reaches the surface, but some 80-90% of the outbound radiation is trapped by the greenhouse gasses, clouds and water vapor [Cline p. 15].

[24] Sea levels would rise for two reasons. First, there is the conventionally understood fact that glaciers will melt turning ice into water. More significant, however, is the tendency for water, like all other materials, to expand when its temperature rises. Most of the observed 8 cm rise in sea levels in the past century has been caused by thermal expansion [Gribbin p. 20]

[25]Societies world-wide rely on a stable climate and nowhere more so than in those countries affected by the monsoon where the failure or even the delay of the monsoon can make all the difference between famine and plenty. Therefore the human implications of improved prediction for sub-seasonal, seasonal and climate timescales are enormous. The countries influenced by the monsoon have predominantly agrarian economies which are very sensitive to the weather and possible changes in the climate. The economies around the world are now so closely linked that the impact of a failed monsoon may be felt worldwide.

Since it depends primarily on the seasonal cycle in the solar heating of the Asian continent, the Indian Summer Monsoon shows remarkable reproducibility from year to year in its evolution, which can be characterized in terms of its onset, established and retreat phases . Although the interannual variations Indian rainfall are not large, nevertheless these can have profound social and economic consequences for the people of India and South East Asia. A weak monsoon year (i.e., significantly less total rainfall than normal) generally corresponds to low crop yields. A strong monsoon usually produces abundant crops, although too much rainfall may produce devastating floods.

For example, in 1995 the monsoon onset over India was later than normal by about one week and its

desert into the Sahel region of Africa is associated with a change in rainfall patterns related to the .6 C rise in global temperatures over the past century [Gribbin p. 17]. In these developing countries their ecosystems are not managed, that is, they are heavily dependent upon naturally occurring rainfall, runoff, and temperatures. In the industrial countries, the source of most of the carbon-dioxide, where the ecosystems of production are managed e.g services, underground mining, communication and manufacturing, the effects of climate change will be *relatively* minimal [Nordhaus JEP 7:4 15].

An unfortunate choice of name

While it is true that greenhouse gasses capture solar heat, they do not work the same way as a greenhouse does. A greenhouse allows solar radiation to pass through the glass and captures the heat by preventing its dissipation through air convection, that is, it prevents the heated air from escaping. "Greenhouse" gasses capture infra-red radiation in the atmosphere and re-radiate back toward earth. Although it is inaccurate, the name "greenhouse effect" to describe the effect of atmospheric gasses on global temperatures has stuck. The name "global heat trap" has been suggested as a replacement.

The greenhouse effect differs from other environmental problems which are typically local and reversible in a policy relevant time frame e.g. air and water pollution. In the case of the greenhouse effect, the problem is cumulative; the stock of these gasses rises from small annual increments and therefore can decline only over a very long time frame i.e. centuries, and is thus not reversible on any meaningful time scale [Cline p. 15]. Of the key green house gasses, methane persists in the atmosphere for ten years, water vapor only eight days, but carbon dioxide has an atmospheric lifetime of nearly one hundred years. Since the industrial revolution the carbon burden of the atmosphere has risen 31% and, according to the IPCC, this increase accounts for about 60% of the global warming since 1850. If current trends [an increase of .3% per year] continue it is expected that the carbon dioxide loading in the atmosphere will rise to twice the pre-industrial level by 2060. Based on these projections, the IPCC (Second Assessment in 1995) estimated that global temperatures could rise between 1-3.5C over the next century [National Geographic

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subsequent progression northwards was slower than usual. Combined with an unprecedented heat wave, this led to severe water and electricity shortages over much of India and considerable hardship for many people.

Seasonal monsoon predictions by the India Meteorological Department, now made for over 100 years using models based on empirical relationships between the monsoon and worldwide climate predictors have been reasonably good. The success of the empirical forecasts would tend to support the idea that a long-term predictability of the monsoon exists whereby slowly "evolving boundary forcing," that is, whatever global forces may be effecting the monsoon they appear to change so slowly as to have no manifest impact in the time-scale of the predictions. Nevertheless, there has been little success in explaining the variability of the monsoon. There seems to be a correlation, for India, between mean annual rainfall and the El Nino and La Nina cycles, but the relationships appear to be weak. At this point then, it is difficult to project the impact of climate change, which is surely a "boundary forcing," on the variability of the Monsoon [P. J. Webster[1], V. O. Magana[2], T. N. Palmer[3], J. Shukla[4], R. A. Tomas[1], M. Yanai[5], and T. Yasunari, Monsoons: Processes, predictability, and the prospects for prediction *Journal of Geophysical Research, Volume 103, C7, June 28, 1998, 14,451--14,510].*

5/98 p. 46-47]. The 2001 IPCC, Group II prediction now, as noted above, having taken account of the cooling effects of sulfates, places the range of increase to as high as 5.8C.

Potential Consequences

Food Production

The world's food supply must double within the next thirty years to feed the population which will double in the next sixty years. Otherwise, before the middle of the next century - as many countries in the developing world run out of enough water to irrigate their crops - population will outrun food supply, and you will se chaos. All we need is another hit from climate change - a series of crop destroying rains - and we're looking down the mouth of a cannon - Dr. Henry Kendall, MIT & 1990 Nobel Prize winner in Physics [quoted in Gelbspan, 1995, p. 154]

As global temperatures rise, soils in the regions that grow half of the world's food will lose moisture to evaporation and will also get less rainfall. As a general pattern it is predicted that the "wet will get wetter and the dry will get drier" [National Geographic 5/98 p. 52-55]. Food production capacity will fall around the world, in the short-run. While it is possible that the potential of other areas to grow food might increase it will take a long time for it to be realized. As the Ehrilchs note:

> Iowa farmers are not likely to pack up quickly, move, and start clearing boreal forests in northern Canada to grow corn, soybeans, or wheat [1992 p. 86].

There are numerous other problems that such a transition would have to face ranging from coping with differences in soil quality to changes in the length of the day at different latitudes that mean reductions in the world output of food for quite a few years (at the very best) if not permanently (which is a real possibility) [Ehrilch & Ehrlich p. 93]. Yet, some economists have questioned whether the consequences for agriculture, at least in the United States, would be significant.

If warming happens as predicted there will be a loss of precipitation and a rise in temperature in the "U.S. heartland," but only under the so-called "dumb-farmer scenario" does this warming pose an insurmountable problem [Mendelsohn et al p. 753]. Most estimates of damage to agriculture assume that farmers will continue to plant the same crops, using the same techniques, in the changed environmental conditions; that is, they fail "to allow for economic substitution as conditions change." Indeed, using a "Ricardian analysis" which allows for crop substitution, Mendesohn *et al* find a warming of the "heartland" will actually raise farm incomes by facilitating the substitution of highly profitable tropical crops [cotton, hay, fruits, vegetables, rice, grapes for relatively low value and relatively economically unimportant grain crops [p.764]. Indeed the study suggest that "irrigated warm weather crops may be the silver-lining behind the climate change cloud"[p. 764] The up-side of warming is only enhanced when one factors in the fertilization effect of rising CO_2 levels. Taking a somewhat broader perspective, however, leads to considerably less optimism.

A recent review of studies of the effects of warming on food production was not very

sanguine. Even when allowance was made for the "fertilization effect" of increased levels of CO_2, and for "smart farmers" "switching to more suitable cultivars," the Environmental Change Unit at the University of Oxford predicted crop yield reductions of 3.2% to 12.3% (depending on which GCM was used top predict climate change). Following yield reduction would come food price increases ranging from 2% to 10% which would in turn increase the percentage of people exposed to the risk of hunger an additional 6% to 47% of the world's population the he risk of hunger [A. Barrie Pittock, Special Issues of Global Environmental Change and Food Policy, *Environment* 37(9): pp. 25-30, November,1995, p. 26]. These numbers include a generous fertilization effect of 22%, but ignore the effects of warming of the availability of water and on the incidence of damage from "pests, diseases and weeds"[p. 26].

Climate and Disease Risk

It is often difficult to tease out the effects of long-term climate change on disease risk from that presented "normal" climate cycles such as produced by El Niño. Isolation of long-term effects obviously requires at better understanding of both the effects of temperature on biota, and separation of short-term and long-term effects. On the other hand, observation of the effects of short-term warming allow one to make inferences about the effects of long-term warming on disease incidence. Alterations in climate associated with El Niño events have been linked to outbreaks of malaria, dengue, Rift Valley fever, African horse sickness, and plague [Harvell et al, 2002]. The is every reason to believe, although one can never be certain, that trend warming will produce similar effects. El Niño does not always produce such effects and surely other "biophysical and epidemiological factors' are germane in any instance [Nevell et al, 2002].

Warming, be it cyclical or trend, effects the disease risk of biota through several channels. First, warming can increase the development rate[26]., and survival rate and the activity levels of pathogens and pests. Recently, for example, temperature changes produced by El Niño Southern Oscillation have been observed to have increased the damage done to coral, oysters, and crops, by "marine and terrestrial pathogens" and to humans and animals from Rift Valley Fever and Cholera [C. Drew Harvell et al, Climate Warming and Disease Risks for Terrestrial and Marine Biota, *Science*, 296, 6 June 2002, p. 2158]. Warming allows pathogens to reproduce faster, to expand their range[27], or to avoid winter kill[28], thus increasing the number of generations produced [Harvell et al 2002]. Nor is there any doubt that the death of the forest on the Kenai Peninsula in Alaska, a forest twice the size of Yellowstone, is climate and pest related. Foresters report that these trees are bleeding to death as sap leaks from holes caused by Spruce beetles

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[26] Shistosoma mansoni lives in a snail for part of its life cycle and in humans for part. Research has shown that a ten degree centigrade increase in water temperature can cut development time in half. Shistosomiasis is already a handicap for hundreds of millions of people.

[27]For example, during the 1980s, . increased ocean temperature allowed the oyster disease, p*erkinsus marimus* to expand northward from Long Island to Maine [Nevell et al, 2002].

[28]"Winter is a major period of pathogen mortality , potentially killing more than 99% of the pathogen population annually." As global warming is expected to increase winter temperatures more dramatically than those of other seasons, the winter "population bottleneck" may be diminished or even removed for many pathogens [Harvell et al, 2002].

who feed on them. The population of Spruce beetles has exploded as average temperatures in Alaska have risen seven degrees over the last 30 and ten degrees in the winter. The dead trees are a catastrophic fire just waiting to happen [Egan, NYT]Nor is there any doubt that the death of the forest on the Kenai Peninsula in Alaska, a forest twice the size of Yellowstone, is climate and pest related. Foresters report that these trees are bleeding to death as sap leaks from holes caused by Spruce beetles who feed on them. The population of Spruce beetles has exploded as average temperatures in Alaska have risen seven degrees over the last 30 and ten degrees in the winter. The dead trees are a catastrophic fire just waiting to happen. .

The "most severe and least predictable" effects of climate change will occur when it leads to alterations in the geographic ranges of either host or parasites. In other words, when behavior changes of either host or pathogen brings the pathogen into contact with a "virgin population." Past examples of such a new convergence are the introduction into North America of Dutch Elm disease and Chestnut Blight which virtually eradicated these species of trees in the United States [Harvell, 2002]. Of course, the effects of small pox and other European "herd diseases" on the Native American population needs no elaboration here.

Vector borne diseases are the most likely candidates for such shifts in geographic range. Vector borne human diseases such as malaria, African typanosomiasis, Lyme disease, tick-borne encephalitis, yellow fever, plague, and dengue fever have surely increased their geographic range over the past few decades [Harvell et al, 2002]. Similar increases in range, primarily into higher latitudes have been observed for disease of livestock [Harvell et al, 2002]. While warming is the likely cause of pathogen mobility, it is not necessarily always the cause. For example, an recent increase in malaria incidence in the African highlands was shown to be the result, not of warming, but rather to increased vector resistance and a deterioration of vector control programs [Harvell et al, 2002].

At present, even without climate change the world is facing a food crisis simply because of expected population growth. Most food experts doubt that the growth rates of food production achieved in the past can be sustained into the future. In India, for example, the "law of diminishing returns" seems to manifest. Between 1974 and 1990, India increased the number to tractors 470%, the consumption of electricity 510%, and the use of fertilizers 480%, yet food yields per hectare increased only 60% [Pittock, p. 28].

Moreover, the worldwide productivity of crop land loss due to soil degradation over the past 50 years has been estimated to be about 13%. For pasture the land the loss has been about 4% [World Resources 2000-2001 p. 64]. These losses have been concentrated in the developing world where future growth in food demand will be the greatest. The global demand for cereals is expected to grow by 40% and for meat by 58% by 2020 with 85% of the growth coming for the developing countries with the most stressed resources [World Resources p. 60].

In China, widespread degradation of its soils due to erosion, poor crop rotation, over-fertilization, and the loss of the organic content, have brought a new plague on the land. One-third of China's crop land is suffering from serious erosion [Gelbspan p. 158]. China is also suffering from the collapse of aquifers that have been depleted by overdrawing. In the northwest, Chinese peasants must walk as much as ten miles to secure their daily supply of water [Gelbspan p. 158]. Added to the loss of soil, fertility and water are the losses of land surface due

to expanded home construction, highways and golf courses. Moreover, Chinese rural farm labor, in a pattern being replicated all over the developing world, is moving to the cities. Some 120 million unemployed, landless people are headed for the coast cities of China where population growth has been averaging 10% per year. Of these cities, most suffer from both water quantity and quality problems, and, in more than 100 of them, the water supply problems are acute.

Malnutrition is now widespread in western and northern China. In 1995, for the first time in its history, China imported more food that it grew domestically [Gelbspan, p. 159]. If China is going to feed its increasing urban and affluent population, it will probably have to purchase even more food elsewhere. It has been noted that if per capital beer consumption were to increase from just one to three bottles per year, China would have to import virtually the entire grain production of Norway. China's growing taste for meat also has grave implications for world grain supplies and prices. Rising food prices augur serious problems for the world's poor, most notably those in Sub-Saharan Africa.

In Sub-Saharan Africa 33% of the population is malnourished [World Resources, 2000-2001, p.60]. It is projected that over the next decade or so, due to stress on soil and water, food production in this region will decline by 20% leaving some 300 million people in a state of permanent malnutrition [Gelbspan 1998, p. 161]. Unable to grow enough food, African nations, plagued with trade deficits, low income and high global food prices, will not be able to purchase it either [Gelbspan p. 161].

Global warming poses far greater threats to food production in nations like India where much of agriculture is dependent on the annual monsoon rains. Should warming alter the pattern of the monsoon, millions of Indian farmers will starve. Moreover, the expected rise in sea level would inundate much of the farmland in Bangladesh delta and other low-lying areas such as the Polynesian Islands. In recent years the frequency of abnormal floods in Bangladesh has increased substantially 1974, 1984, 1987, 1988, 1991 and 1993. Normally the monsoon floods cover 20% of the territory one year out of two. The disastrous river floods of 1987 and 1988 inundated 40 and 60% of the country, respectively. To make matters worse, it is predicted that rainfall in Bangladesh may increase by up to 18% in the wake of further warming.

As temperatures rise, the melting of the polar ice-cap and the thermal expansion of the oceans with push up sea levels around the world. Early in 1995 climatologists were alarmed when 400 square miles of antarctic ice fell into the sea. They see this as a precursor of things to come as the earth's atmosphere continues to warm.

Storms will gather more energy from the warmer sea and be more devastating. Flooding will become more prevalent for two reasons. First, as precipitation that normally accumulated as mountain snow and slowly dispersed in the spring melt now rushes through the watershed as it falls.[29] Second, increases in rainfall intensity are now a well-established result of global

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[29] On a recent trip to I witnessed first hand the devastating effects of such flooding. Red Rock State park, just outside Sedona, has had 3 "hundred year floods" (floods so severe they are expected only every 100 years) in the past four years. The reason, excessively warm winters. I walked over a bridge that, at the time was 35 feet above the level of the river below. The ranger informed me that during the flood the bridge was awash. As we walked through the canyon, as we stood some 20 feet above the river we could see flood debris in the trees 10 feet above our

warming" [Pittock, p. 29]. Combined with ongoing deforestation, the more intense rainfall will produce not only more flooding, but more erosion as well. But, a melting ice cap might have even more devastating effects through its effects of on world weather patterns.

Weather patterns are heavily influenced by ocean currents which are in turn influenced by gradients in the temperature and salinity of water. Warmer, less saline waters might significantly alter the ocean "conveyor systems" in ways that could lead to dramatic changes in weather patterns [Broecker 1995 p.62]. Indeed, the current "consistent"[30] global climate pattern seems to be dependent on the maintenance of the current polar ice pack. A sudden jolt of fresh water, produced by the melting ice-cap could produce catastrophic shifts in weather patterns [Broecker 1995 p. 62].

CO_2 - The Champion Anthropogenic Greenhouse Gas

CO_2 reduces the amount of infrared radiation that escapes into space.[31] CO_2 accounts for about 2/3 of the greenhouse effect, methane accounts for 15%, CFCs for about 24% and nitrous oxide for about 6% [Cline p. 17]. The sun sends 340 watts per sq. meter per second of

> Greenhouse skeptics have made much of the fact that most of the observed warming over the past century had occurred prior to 1940 while most of the CO_2 emissions have been since 1940. One explanation offered to this criticism was that the oceans absorbed much of the heat produced by the warming since 1940. Recently, however, it has been shown that the burning of fossil fuels releases sulfate particles along with CO_2. The sulphate particles, in addition to be promoting lung cancer and acid rain, also promote cloud formation. The 2001 report of the IPCC indicates that the cloud cover over mid- to high latitude land areas increased by abut 2% [Group I, Summary p. 4] Thus, by producing clouds that reflect sunlight back into space, the sulphate emissions have been masking the temperature increases that otherwise would have occurred consequent to the growth of CO_2 emissions. Eventually, as CO_2 persists in the atmosphere much longer than these sulfate aerosols, and since there has been a concerted, and successful effort (at least in the US) to reduce these sulfate aerosols, this masking effect will be of little long-run significance.

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heads.

[30] Cores drilled in the Greenland ice-cap reveal a series of cold snaps and warm spells (with shifts of +- 10 degrees C) each lasting about 1000 years were common up to the end of the last ice age. Since them the climate has been stable [Broecker 1995 p. 62.]

[31] Carbon dioxide, water vapor and methane absorb infrared radiation thus making the air warm. The air itself then radiates infrared energy some of which goes toward earth making it warmer. Infrared heat is what you feel when you stand near a radiator or another person. Unlike the visible light of the sun's radiation the human eye cannot see infrared radiation, but you can feel it. The "greenhouse effect" is actually a misnomer. A greenhouse is warmed because the glass prevents warm air from escaping. Global warming is the result of infrared radiation being captured by the air and radiated back toward earth [Gribbin p. 26 and n. p. 27].

energy to the earth. 100 watts, about 30% is reflected back by the "planetary albedo effect" of snow, ice, clouds and aerosols [Schneider, Global Warming, p. 14]. Clouds account for about 80% of this albedo effect. The balance of 240 watts warms the earth and the atmosphere. Each second every square meter of the earth radiates 420 watts of heat. However, because of the greenhouse effect, only about 240 watts will escape into space; 180 watts are radiated back to earth warming it by 33C [Cline p. 16]. Indeed, were it not for the greenhouse effect of $CO_{2,,}$ and the other greenhouse gasses the Earth's temperature would be about (-18) C compared to the to the present average of about 14C [Cline p. 16]. Since 1750 the increase in "radiative forcing" due to the greenhouse effect is estimated to be about 2.43 watts/meter^2 About 1.46 of this total was due to CO_2, .48 from methane, .34 from halocarbons, and .15 from N_20 [IPCC (2001), Group I, Summary p. 7].

The energy gain from solar radiation varies with latitude. In the tropical latitudes (30N-30S) there is a net energy gain. In the northen latitudes, due to the high reflectivity of snow, there is an energy deficit. In the middle latitudes, there is an approximate energy balance. On the earth, atmospheric circulation tends to move energy from the areas of gain to areas of deficit. It is not known at this time how CO_2 levels alter energy balances and thus atmospheric circulation [E. Mezaros, *Atmospheric Chemistry*, p. 165].

In 1896, Savante Arrhenius, a Swedish scientist calculated that a doubling of the CO_2 loading in the atmosphere would raise the earth's average temperature between 7 to 10 degrees F. Arrhenius saw the consequent rise in global temperatures as a purely salutary event. As a Swede, he surely could appreciate a warmer climate and the opening up to farming of more of the northern hemisphere. However, instead of realizing a "climatic nirvana," as one observer put it,"we are stewing in our own juices" [Gale Christensen, Providence Journal 7/14/99]. Before the industrial revolution the CO_2 loading in the atmosphere was 275 ppm. By 1991 it had risen, at a rate of 1.5 ppm per year, to 355 ppm. Each year the burning of fossil fuels (coal, oil and natural gas) and other organic materials such as trees, adds about six-seven billion tons of carbon

Phytoplankton are the predominant plants of the ocean. These single-celled organisms float in the trillions over the world's oceans, and by their photosynthetic activities they process about 40% of the Earth's carbon annually (43 billion tons of CO2). Carbon dioxide levels have been gradually rising in recent decades, and are likely to be a major factor in global warming. Any factor that might affect phytoplankton growth is thus of great scientific interest.

Recently, scientists from Brookhaven National Laboratory (BNL) made a surprising discovery during two oceanic studies: the ocean's phytoplankton are starved for iron. If supplemented with iron, they proliferate rapidly and, in the process, increase their consumption of CO2.

Despite being one of the most abundant elements in the earth's crust and one of the most common metals present in soils and rocks, iron is not abundant in aquatic systems because it is relatively insoluble in water. Consequently it is unavailable to living organisms as dissolved iron.

It is difficult to estimate exactly how much iron is available to phytoplankton in the oceans. In one study carried out in the vicinity of the Galapagos Islands, scientists fertilized an ocean region 25 miles square by adding iron (in the form a soluble iron salt ferrous sulfate, $FeSO_4$) three times over an 8-day period, while measuring phytoplankton growth. The phytoplankton responded quickly and dramatically: an area 6 miles wide and 81 feet deep turned bright green with phytoplankton, and the color lasted for 2 weeks. The scientists concluded that these and other observations provide unequivocal support for the hypothesis that the year-round persistence of high concentrations of the plant nutrients nitrate and phosphate in this ocean region is due to limited iron bioavailability. These results suggest that unless a way is found to increase the amount of available iron in the oceans, the contribution of the ocean as a carbon sink has reached its maximum.

to the earth's atmosphere [Ehrlich & Ehrlich p.74].[32] The effect of this rising CO_2 loading has been to warm the Earth. This effect of CO_2 is exacerbated by a *positive feedback*. As the CO_2 load drives up atmospheric temperature more water vapor is produced by evaporation of the oceans and water vapor, because it absorbs infrared radiation from across the infrared spectrum,[33] is the "single most important greenhouse gas"[34] [Gribbin p. 132]. The positive feedback effect of water vapor amplifies the temperature increase produced by rising levels of CO_2 by a factor of three! [Gribbin p. 132]. Global Climate Models that incorporated the vapor feedback predicted a doubling of CO_2 from 300 ppm to 600 ppm will raise the global temperature from 3.5 to 4.5 degrees centigrade.

The missing sink

The IPCC (2001, Group I, Summary p. 7) reported that "currently the oceans and land together are taking up about 50% of the anthropogenic emissions of CO_2." Scientists have long been puzzled by the result of carbon accounting, that is, the measurement and comparison of carbon emissions to the absorption of carbon in known "carbon sinks" such as the ocean and forests. The oceans serve as a "sink" for about 2 billion tons of carbon dioxide, but the mechanism is not understood. Indeed, scientists found some 4 billion tons less, which is just over one-half of the seven tons of emissions of carbon into the atmosphere that they expected to find given emissions and natural absorption [NY Times 11/1/97].

Phytoplankon play an important role as a carbon-sink. The organisms take CO_2 from the air and the oceans and convert it into calcium carbonate shells. When they die, their shells are deposited and sequestered on the ocean floor where over the eons it is turned into limestone. At present, the ability of the ocean to scrub CO_2 from the atmosphere is limited by the amount of iron in the oceans. Iron apparently limits the population of phytoplankton.

Just recently, scientists were astounded to find that forests absorbed much more carbon[35] than previously believed. Some scientists believe this is the result of the "fertilizing effect" of CO_2 and the warmer climate. This is a negative feedback that may mitigate the warming effect of carbon emissions [Flavin in Brown 1996 p. 24]. A recent report in *Science*

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[32]9. Fossil fuel burning adds about 5.4 billion tons (gigatons) and deforestation adds another 1.6. However, the annual increment in atmospheric CO2 is only 3.4 gigatons. About 2 gigatons is absorbed into the ocean, leaving a shortfall of 1.6 gigatons. There is apparently sone unknown "sink" for carbon dioxide [Cline p. 16].

[33]7 CO2 absorbs infrared radiation only in the wave band of 13 to 17 micrometers. Water vapor absorbs from above 25 mm to under 6 mm [Gribbin p. 130].

[34] The absence of water vapor explains why arid areas like deserts are so hot during the day and so very cold at night. In humid areas, water vapor captures some of the infrared radiation that in arid deserts just radiates out into space.

[35] Plants absorb carbon in the process of photosynthesis. Higher levels of carbon in the air should promote plant growth.

concluded "that over the past two decades, there has been a greening trend in the northern latitudes, associated with a gradual lengthening of the growing season" due to slight warming of the boreal climate [Wolfgang Lucht et al, Climate Control of the High Latitude Vegetation Greening Trend and Pinatubo Effect, *Science* 296, 31 May 2002, p.1687]. While deforestation is proceeding at an alarming pace in the tropics, the forests of the northern hemisphere, in Canada, the United States and Russia are expanding as lumbering and agriculture decline in these regions [NY Times 11/1/97]. Moreover, the growing supply of atmospheric carbon is promoting the growth of these forests. A Russian scientist has estimated that the potential[36] expansion of the Russian forests could drain as much as two billion tons more per year of carbon - an amount equal to three years of Russian fossil fuel emissions! [NY Times 11/1/97]. The problem is a complex one, however, and the future is uncertain. As the rising atmospheric carbon load encourages the expansion of the northern end of the Russian forests there is some evidence that rising temperatures are killing trees on the southern edge primarily as a consequence of the expanding range of pests like silk worms and bark beetles. The dead trees also raise the threat of carbon releasing forest fires [NY Times 11/1/97]. It is impossible at the moment to predict the net effects of these opposing forces.

The recent (1997) Kyoto meetings failed to reach a final agreement on global emissions reduction because, subsequent to the signing of the treaty, the United States insisted that it be given emissions credit for the expansion of its forests. In other words, as US forests constitute a larger sink for carbon the US should not be required to cut its emissions by as much as it agreed to do in Kyoto. In any case, the issue became moot when, in March of 2001, newly elected oil-man, president George Bush announced that he would not abide by the Kyoto Protocol at all.

Climate history

The key issue is not whether the earth is warming, there is little doubt here, but whether the origin of the trend is anthropogenic. In short, has the earth been this warm before? If so one

[36] The Russian scientist, Dr. Olga Krankina, insists, however, that this gain is to be realized the Russians will have to do a better job managing their forests, most especially in the domain of reducing forest fires [NY Times 11/1/97].

might suspect natural cycles are at work. It is manifest that one cannot comprehend the significance of present variations in temperature, and the role of humans in producing them,, without some understanding of past climate changes that were independent of human influence. In short, some historical perspective is essential.

> According to Jonathan Overpeck, the chief of paleoclimatology at NOAA, the "medieval warming" never happened. There was, he contends, no global warming in that period, but rather a local warming, due to a shift in ocean currents that did not extend much beyond Europe. Indeed, since a seminal article published in 1965 questions the reality of the "medieval global warming," many scientists have concurred that it never happened. The political effect of this finding is enormous. It means that aside for the "climate optimum" some 6,000 years ago, the 1990s is now the warmest period in earth history and lends a great deal of credence to the notion that the current warming is unnatural, that is, it is anthropogenic in origin.

The Earth is about 4.6 billion years old. For most of Earth's history it was, evidently, much warmer than it is at present. There are several notable exceptions such as the late and mid-Pre-Cambrian, and the transition from the Carboniferous to the Permian, and the Pleistocene. For the first 500-600 million years, the earth was warm enough to be free of ice even at the poles [Meszaros, p. 162]. At the beginning of the Cretaceous period (about 150 million years ago), however, temperatures began to decline and continued to do so (if around cycles) until about 100,000 years ago.The glaciation of Antarctica began about 5 million years ago and that of Greenland about two million years ago [Meszaros p. 162].

About 2-3 million years ago the cycle of Ice Ages began. The ice sheet that now exists year-round in the polar regions began a cycle of expansion into non-polar regions, and then retreat over a period of about 40,000 years. About 800,000 years ago, the period of the cycle shifted to about 100,000 years, with several shorter cycles contained within the major cycle [Schneider, Global Warming, p. 38].

During the past 1.8 million years, a era dominated by the Pleistocene, it would appear that the "ice ages" were (are) the norm, and the warm, 10,000 year "interglacials," like the one we are enjoying now, are aberrations. During the Pleistocene glaciers would build up over a 90,000 year period and, following rapid warming, melt in the short span of 10,000 years. The last ice age reached maximum glaciation about 20,000 years ago, but by 10,000 years ago the glaciers were virtually gone [Meszaros, p. 163]. For the past 8,000 years the global temperature has fluctuated by 1-2C, but has followed a flat trend, i.e. been virtually constant [Meszaros, p. 163].

The trends and cycles in climate have been attributed to a number of factors [Meszaros p. 163]:

1/ Variations in solar activity.
2/ Variations in the orbit and tilt of the earth, the so-called Milankovich cycles.
3/ Variations in the quantity of CO_2 and volcanic dust in the atmosphere.

4/ Changes in the position and size of the continents.
5/ Variations in ocean currents
6/ Internal random fluctuations in the of the climate system

Solar Activity

As we shall later when we discuss the "faint sun paradox," the power of the sun or "solar forcing" has, at least the potential to have a substantial influence on the climate on Earth. But, the faint sun paradox has to do with the growth in the actual size of the sun over billions of years. Changes in solar activity, which many of the global climate "naysayers" attribute the recent warming trend, however, involves much shorter solar cycles of "sunspots." An increase of just 0.2% in the solar output could have the same effect as doubling the carbon dioxide in the Earth's atmosphere. Coupled with fact that the sun is currently more active than it has been in the past 300 years, such an assertion is not unreasonable on its face. However, in 1995 a researcher at AT&T Bell Labs reported that the effects of cycles in solar forcing were relatively weak compared to the effect of the accumulation of greenhouse gasses [Gelbspan (1997), *The Heat is On*, p. 29]. The researcher found that the enormous increase in emissions since the beginning of WWII has actually affected the timing of the seasons. Since 1940, the spring season has been coming earlier each year. In the northern hemisphere, other researchers have reported, spring is now arriving a full week earlier than it did just twenty years ago [Gelbspan, p. 29]. A recent study of the timing of the flowering of plants in Britain found that, over the decade of the 1990s, flowering time advanced some 15 days. The authors concluded that since "flowering is especially sensitive to temperature," this observation constitutes "the strongest biological sign yet of climate change"[A.H. Fitter and R.S. Fitter, Rapid Changes in the Flowering Time in British Plants, Science, 296 31 May 2002, p. 1689].

Solar activity is measured by the sunspot index which is formulated by counting the number of sunspot groups and the number of spots within each group. Solar activity is directly related to the sunspot index. Also, there are strong statistical associations linking current trends in climate (surface temperatures) to trends in solar activity. For example, using ancient tree rings, scientists have found 17 out of 19 warm spells in the last 10,000 years coincided with peaks in solar activity [http://news6.thdo.bbc.co.uk/hi/english/sci/tech/newsid_56000/56456.stm, and
http://science.msfc.nasa.gov/newhome/headlines/ast13apr98_1.htm].

Sunspots vary on a fairly predictable 11-year cycle, but these cycles do not exactly replicate each other. For example, early records of sunspots indicate that the Sun went through a period of inactivity in the late 17th century. Very few sunspots were seen on the Sun from about 1645 to 1715. This period of solar inactivity also corresponds to a climatic period called the "Little Ice Age" when rivers, such as Thames in London, that were normally ice-free, froze and the snow cover remained year-round at lower altitudes. Even when the Little Ice Age reached its coldest point in the span from 1570 to 1730, average global temperature appears to have cooled by no more than 2 degrees Fahrenheit. However, these relatively small temperature changes can produce catastrophic human effects because they fluctuate in certain regions much more than the world as a whole.

There is evidence that the Sun has had similar periods of inactivity in the more distant past. But, the linkage between solar activity and earth's climate is an area of on-going research. Nevertheless, it is worth noting that some astronomers have predicted that the solar cycle peaking around the turn of the century will be an unusually large one.

The sun now is on the upswing of its 23rd activity cycle, a numbering scheme that dates from the mid-19th century, following introduction of the "relative sunspot number" by Rudolf Wolf of the Zurich Observatory in 1848. Wolf's sunspot number (now called the International sunspot number or the Zurich number) represents a blend of actual numbers of individual spots and numbers of groups of spots on the sun.

On average, this number varies from a minimum through a maximum to the next minimum in about 11 years. Because the solar magnetic fields reverse at the peak of each 11-year cycle, solar activity cycle actually spans a 22-year "Hale cycle." Cycle 23 is the last half of the current Hale cycle (composed of Cycles 22 and 23) that began in 1986. The consensus [among solar physicists] is that this cycle will be above average in size and probably a fast riser, Sunspot maximum should not be perceived as the top of the cycle curve, but instead it should be thought of as an interval of peak activity which usually spans about 2 to 4 years and includes the actual maximum in sunspot number For Cycle 23, the peak interval starts in 1999. If so, a solar contribution to global warming might occur that would add to the expected contribution from increased greenhouse-gas loading. It has been speculated that only a .4% decline in solar activity would have been sufficient to cause the "Little Ice Age." One can only speculate what would happen should there be a .4% increase in our CO_2 enriched atmosphere. In any case, should sunspots force up global temperatures, it would be primarily due to the amplification of its small effects by the increased loading of CO_2 in the air.
[http://earth.agu.org/revgeophys/reid00/node2.html and
http://science.msfc.nasa.gov/ssl/pad/solar/sunspots.htm].

The IPCC's draft of the Third Assessment Report (TAR 2000) estimates the Sun's role in climate change to be minimal. According to the expert review, "the temporal evolution indicates that the net natural forcing (solar and volcanic aerosol) has been negative over the past two and possibly even the past four decades. The solar forcing estimate is seen as "considerably smaller than the anthropogenic greenhouse factors." Taking everything together, TAR 2000 considers it "unlikely that natural forcing can explain the warming in the latter half of this century."

Milankovitch Cycles

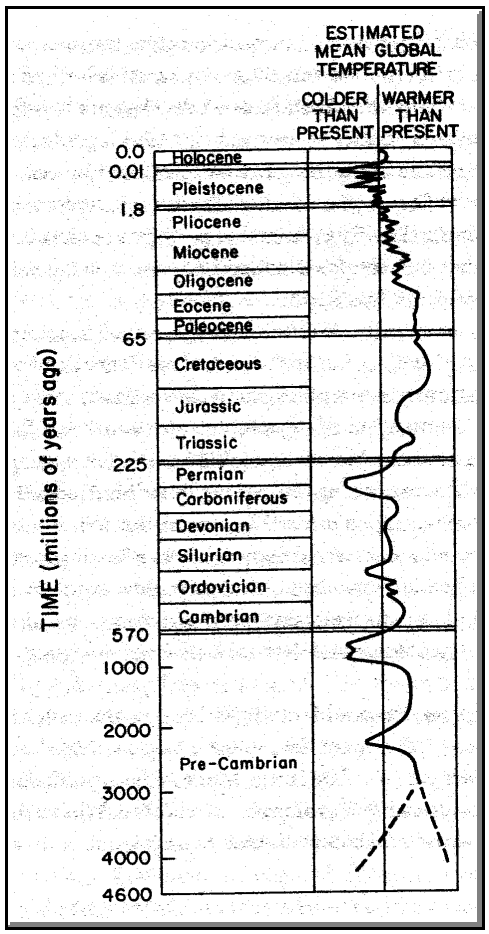
Ice ages are a regular feature of Earth's recent history. Ice ages are believed to be caused by what are known as Milankovitch cycles.[37] Variations from circular to elliptical in the Earth's

[37] The earth's orbit around the sun varies from circular to elliptical back to circular over a 100,000 year period. The amount of solar energy reaching the northern hemisphere of earth is also influenced by changes in the tilt of the earth producing a 41,000 year cycle of warming and cooling. Finally, the earth wobbles around its axis producing a 23,000 year cycle of warming and cooling. These cycles were first noticed by Scotsman James Croll in the late 1800s and refined by a Serbian mathematician, Milutin Milankovitch early in the 20th century. The 100,000 year cycle is attributed to three oceanographers (James Hays, John Imbrie, and Nicholas Shackelton). In 1976, they

orbit around the sun can lead to variance in the distance from the Earth to the Sun. When the orbit is at its most elliptical phase, the amount of sunlight hitting the earth is more variable over the year, thus, at some point the winters get colder. Changes in the "eccentricty" produce a 100,000 years temperature cycle.

But eccentricity is not the only Milankovitch factor. While the sun orbits the earth, the tilt, or the obliquity of its axis also changes. The greater the tilt, the warmer the summers and the colder the winters. Obliquity varies over a 41,000 year cycle.

Finally, the Earth's axis wobbles, as it moves around the sun, producing a 20,000 year "precession" cycle. Changes in precession alters the season during which the earth is closest to the sun. The major ice ages occurred when these forces combine in a way that producing the least amount of solar forcing to the northern hemisphere in the summer season.



Source: Stephen Schneider, Laboratory Earth, p. 17.

The "interglacials", the relatively warm periods, between Ice Ages last from 10,000 to 20,000 years. The present interglacial began about 10,000 years ago. So it seems that another ice age will begin within the next 5000 years.

At present, global temperatures are about 5 degrees C above those of the last Ice Age. The warmest period in the present interglacial occurred about 6,000 years ago, (a time known as the climate optimum) but that temperature was only .5 C above present global temperatures [Gribbin p. 18, but see box]. Indeed, if one looks only at the Milankovitch cycle, one would expect the earth to be cooling now, not warming [National Geographic 5/98 p. 51]. Nevertheless, since the world has been warmer on two occasions - the climate optimum, some 6-9000 years ago, and the "medieval warming" during the 11-13th centuries, one cannot call current temperatures "unnatural." Nevertheless, it is worthy of note, that global temperatures are rising at a historically unprecedented rate. Climate scientist Stephen Schneider writes:

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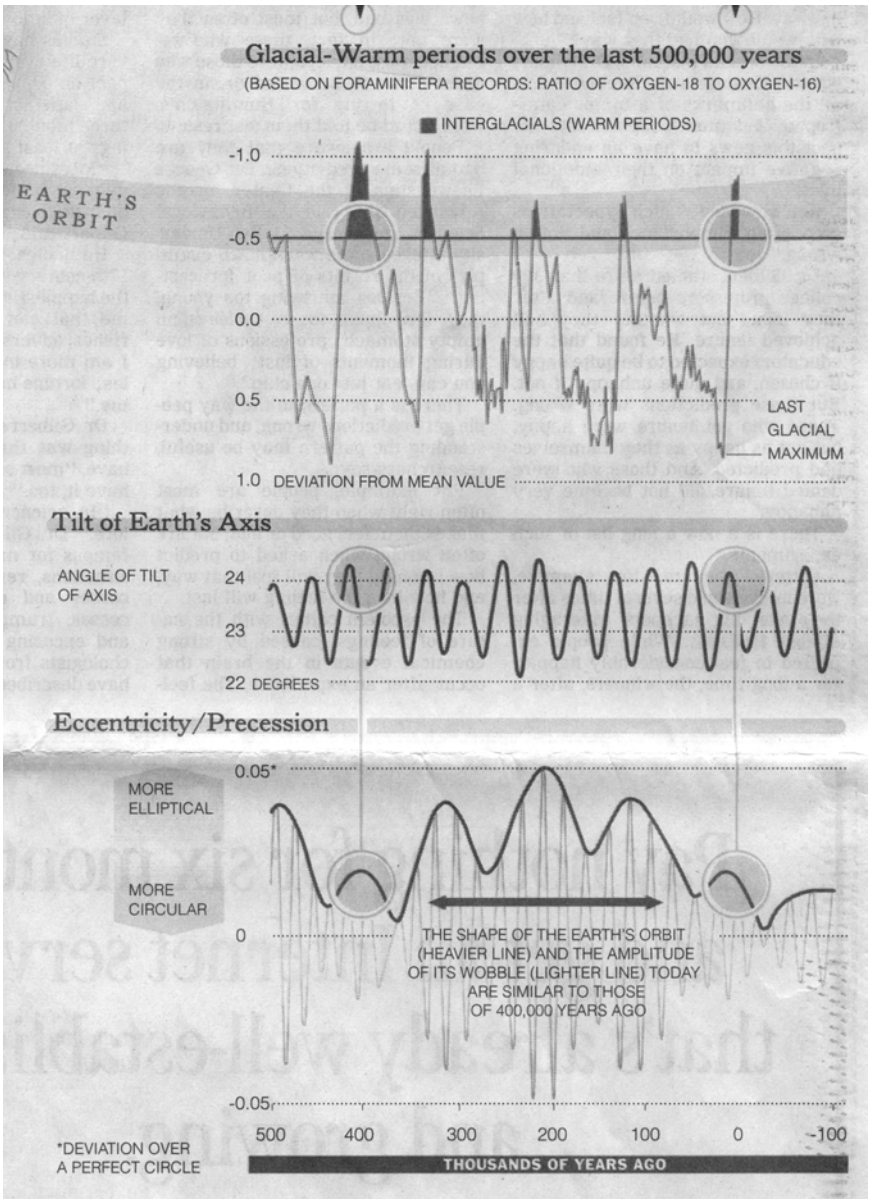
found evidence that supported the advance and retreat of the ice pack in cycle of 23 and 41 thousand years as Milankovitch predicted, but they also found evidence of a 100,000 year cycle in cores of mud pulled from the ocean floor. They reasoned this cycle was caused by changes in the orbit of the earth from elliptical to circular. Milankovitch had minimized this effect on climate and the oceanographers have not been able to explain why the change in orbit has such an impact as the change in orbit has a small effect on the amount of sunlight hitting the planet [Monastersky, p. 220]. Empirically, the 100,000 year cycle is there, but it has not been successfully explained. One possibility is that the orbital change could affect the latitudinal and season distribution of sunlight. Stephen Schneider claims that 9,000 years ago, this "orbital forcing" increased the amount of summer sunlight in the northern hemisphere by about 8% [Schneider Laboratory Earth p. 91].



Source: New York Times, Science Times, 2/16/99, p.1

During the Holocene, recent ecosystems and habitats settled into the forms we know, following a 5C globally averaged temperature rise and a 100 meter sea level rise that marked the 5000 year transition from the last ice age to the current interglacial. It took nature roughly 5-10,000 years to transform the landscape from ice of much of North America, Europe and high-latitude seas to more current conditions, in which ice is predominantly in polar seas and continents and high mountains. Since this transition coincides with about 5c global warming, we can estimate that natural rates of temperature change on a sustained global basis are thus 1C per millennium..... Thus, a warming of just 1C per hundred year periods [is] ten times faster than the natural rate of sustained global temperature change [Schneider, *Laboratory Earth,* p.58, 59].

Milankovitch cycles, whatever their relevance to long cycles in climate, work on too long a time scale to explain the rise in temperature observed over a mere century or even over a few decades. In any case, it would appear that the present state of the Milankovitch cycle would appear to be contributing toward cooling. Indeed, the cycle seems to be at a stage similar to that

which existed about 400,000 years ago when the Earth entered a cooling period that lasted nearly 50,000 years. At present the earth orbit is nearly circular and the "wobble" is relatively small, and the "tilt" is near its cyclical maximum, all of which reduce the amount of sunlight that hits the northern latitudes. The decline in sunlight results in less snow melt which leads in turn to more albedo which leads to less snow melt. In short, a cooling positive feedback cycle begins [William K. Stevens, In Ancient Ice Ages, Clues to Climate, *New York Times*, Feb. 16, 1999].

Clearly, should the Earth should continue to warm as predicted by the GCM's we will be entering a new climactic era; the earth will be warming at an unprecedented rate and it will be warmer than it has been in 100,000 years [Gribbin p. 18-19]. It was, thus, the consensus of a conference of the World Meteorological Organization held in Toronto in 1988, that "humanity is conducting an enormous, unintended, globally pervasive experiment whose ultimate consequences could be second only to global nuclear war" [quoted in Gribbin p. 2].

Variations in Ocean Currents

Milankovitch cycles change the climate slowly over millennia. There are other forces, that may be triggered by climate change that can produce radical changes in a climate in a matter of years. For example, ice cores from Greenland representing the last ice age show several occasions where temperatures shot up as much as 6 degrees in perhaps one single decade. The most obvious candidate for causing these changes is the Atlantic thermohaline circulation, popularly known as the ocean "conveyor belt" system that transports warm water from the equator to the North Atlantic and in doing so makes an substantial contribution tot he "heat budget of the North Atlantic"[Stephan Rahmstorf [2000], "The Thermohaline Circulation: A System with Dangerous Thresholds?", *Climate Change*, 46:247-256, p. 247]. The Amount of heat brought to the North Atlantic by the conveyor system is equal to one-third the amount of heat the area gets from the Sun [Gribbin, p. 160], and this contribution of heat can raise the local temperature by as much as 10C [Rahamstorf, p.247]. North Atlantic water is both warmer and saltier[38] than the waters of the North Pacific. As a result the colder, saltier, heavier North Atlantic water sinks, and begins to move south around Africa and Australia into the Indian Ocean where it loses some salinity by mixing, rises, warms and turns around to head north. The cycle takes about 1000[39] years to complete [Schneider, *Global Warming*, p. 52]. This system warms the continents in the North Atlantic, especially Europe[40], which benefits from the easterly

[38] Higher rates of evaporation relative to precipitation over the ocean and runoff from land produce more salinity in the North Atlantic compared to the northern Pacific [Schneider, Global Warming, p. 52]. Also in the winter, as the water gets colder, it also gets more saline as surface freshwater freezes. The remaining water is more saline and hence more dense (heavier) so it sinks.

[39] Newer data indicate the time period for the movement of water from Greenland to the northern Pacific is about 2000 years.

[40] Europe is at the same latitude as Siberia and Hudson Bay but is much warmer due only to the warm waters of the Gulf Stream [Schneider, Global Warming p,47]

prevailing winds.[41] It is thought that the "flips" in temperature observed as the glaciers began to retreat some 10,000 years ago may have been caused by this current turning "off" and "on." There is solid evidence that this current was turned off both during the last ice age, and a period of ice age weather some 10,000 years ago known as the "Younger Dryas."

Some 10,000 years ago, as the temperature rose and glaciers melted, snowmelt and increased rainfall led to a massive infusion[42] of fresh water into the North Atlantic which lowered
its salinity. The North Atlantic then froze, blocking the normal flow of warm water into the region. Consequently, the warming deep ocean current, shifted from northeast to dead east. Northwestern Europe went rapidly back to ice age conditions in a period known as the Younger Dryas, after a small beautiful flower that prospers in arctic conditions [Schneider, *Global Warming* p. 51]. It is now feared that a rise in temperature promoted by greenhouse gasses might alter both the temperature and salinity differentials that drive this conveyor and stop or alter the flow. If this should happen, Ireland would have the climate of the Arctic circle and most of Northern Europe would be uninhabitable even as the rest of the earth warmed [Schneider, *Global Warming*, p. 54] . A study published in *Nature* in 1997 predicted that this current could shut down if the carbon dioxide level in the atmosphere doubled over the next century. Most scientists believe the latter is inevitable [NYT 1/27/98, *National Geographic* 5/98]. But, some climate models suggest it would take at least a quadrupling of carbon dioxide to completely shut-down the conveyor system, i.e an increase in global temperature of 4-5C [Rahmstorf, p. 253]. And, warming alone will not do it, a substantial infusion of freshwater would also be necessary [Ramstorf, p. 253].

It is generally accepted that rising global temperature will lead to more evaporation and more precipitation in the northern hemisphere. As precipitation increases the flow of fresh water from rivers into the north Atlantic will slowly reduce the salinity of these waters. Since salinity is critical to the sinking of cold water, and hence, to the functioning of the conveyor system, some scientists believe that by 2050, the conveyor may slow down or even stop.

In December of 2002, scientists reported that the flow fresh water from Eurasian rivers

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[41] Europe also benefits from the Gulf Stream. An important component of the global oceanic "conveyor," the Gulf Stream carries tropical warmth up the eastern seaboard of the United States to the North Atlantic and Europe. Without its warming influence, a summer swim off the coast of Rhode Island would resemble a swim in ice water and the constant winter drizzle of London would likely all be snow. Just recently, Nature, Lamont-Doherty Earth Observatory geochemist Jean Lynch-Stieglitz presented evidence that the Gulf Stream, operated at about two-thirds its current rate during the height of the last ice age. As it is powered in part by the ocean conveyor, Lynch-Stieglitz, believes that the one-third drop in the strength of the Gulf Stream can be directly attributed to a cessation in main ocean conveyor system.[University Daily Science News, 13-Dec-1999].

[42]It has been speculated that the massive influx of fresh water happened when a melting glacier, that had been funneling meltwater down the Mississippi, gave way allowing a massive amount of fresh water to flow down the St. Lawrence into the North Atlantic [Schneider, Global Warming p. 53] Proglacial Lake Agassiz drained into the Mississippi. This switch was triggered by the retreat of the Laurentian ice cap, which formed the northern shoreline of the lake. When the ice dam gave way Lake Agassiz drained into the North Atlantic by way of the St. Lawrence.

into the Arctic Ocean has increased some 7% since the 1930s [Science, 298, 13 Dec. 2002, p. 2110]. This influx of an additional 128 cubic kilometers of fresh water will only grow over time as global warming increases precipitation over the northern latitudes. While precise projections cannot be made, some scientists are concerned that, by the end of the century, salinity would have been diminished sufficiently to turn of the ocean conveyor system and put northwestern Europe into another Younger Dryas.

In any case, over the past 10,000 years there is no evidence that ocean currents have contributed to either global warming or cooling. There is some concern that rising global temperatures may cause the melting of glaciers, and the resultant flow of fresh water into the North Atlantic may reduce salinity enough to bring the ocean conveyor system to a halt. But, climate scientist Wallace Broecker, a marine geochemist at Columbia University, who also happens to be a founding father of the conveyor model of ocean circulation, notes that predicting another Younger Dryas may be rash, as the latter took place at the end of an ice age when condition were very different than they would be in an overheated world. Indeed, Stephan Rahmstorf of the Potsdam Institute for Climate Research has speculated that the system may be more stable in the "Holocene warm mode" than it was in the "cold glacial mode"[Rahmstorf, p. 252]. Even so, Broecker contends that the conveyor system is the "Achilles heel of the climate system," it would take only a slight rise in temperature to keep water from sinking in the North Atlantic and this would bring the conveyor to a halt. Nevertheless, there are still great uncertainties in the understanding of how the Earth climate changes and the precise effect of all the factors that affect the weather. Hence, Brocker warns:

> The fact that we are unable to provide satisfactory estimates of the probability that a conveyor shutdown will occur, or of its consequences, is certainly reason to be extremely prudent with regard to CO_2 emissions. The record of events that transpired during the last glacial period sends us the clear warning that by adding greenhouse gases to the atmosphere, we are poking an angry beast [W. S. Broecker, "What If the Conveyor Were to Shut Down? Reflections on a Possible Outcome of the Great Global Experiment," *GSA Today* 9(1):1-7 (January 1999)].

The ocean conveyor system has been implicated in changes in weather patterns, especially rainfall and hurricanes. George Taylor, the state climatologist at Oregon State University and president of the American Association of State Climatologists claims that the activity of the conveyor varies over a cycle of 15 to 20 years. When the conveyor is more active, the Atlantic warms up and causes the jet stream to shift to the north. Normally the jet stream, which blows east to west, protects the Atlantic coast form hurricanes by blowing them out to sea. When the jet stream shifts to the north, the Atlantic coast is unprotected. Right now the Atlantic is about four degrees warmer than normal. Taylor predicts that we are in for about 15 years of more frequent and intense hurricanes due to this warmer water. It is not clear what is causing the increased activity of the ocean conveyor, but Taylor suspects the sunspot cycle [http://www.enn.com/enn-news-archive/1999/09/092699/conveyor_5908.asp].

The Size and Position of the Continents

Over geological time, the continents have moved considerably. One hundred and sixty million years ago, Western Africa was no further from the Eastern United States than Cuba is now and it was still joined to South America. At the same time what is now Boston was at 30 north latitude, the latitude which defines the tropical zone (0-30). At present, we find Savannah at that latitude. The size and position of the continents surely has played an important role in shaping climate change when the latter is considered on a geological scale. The spatial distribution of the continents is a major determinant not only of latitude, but of the flow of ocean currents. The present pattern of ocean currents was established about 2.5 million years ago when the Isthmus of Panama closed and radically altered the routes of ocean currents. At about the same time, the collision of India with Asia formed the Himalayas and permanently alters the patterns of atmospheric circulation. The glaciation of Antarctica is no doubt related to changes in ocean currents consequent to Australia breaking away some 55 million years ago [Schneider, Laboratory Earth, p. 15] But, since the continents drift slowly, the pattern hasn't changed much over the past century, and hence, it cannot be responsible for the unusual warming over the past century.

Methane

Methane is a potent greenhouse gas. Compared to carbon dioxide which remains in the atmosphere for as long as 100 years, Methane stays in the atmosphere only for some 8-10 years before it is broken down by solar radiation. It follows that measures to reduce emissions of methane could produce quick declines in the atmospheric burden of methane and hence, fairly rapid mitigation of global warming. As we shall see, one of the main anthropogenic source of methane emissions is the careless disposal of natural gas by flaring, and by leaks in natural gas transmission lines. Of late (2003) natural gas prices have been rising. Perhaps the rising price will provide economic incentives to stem the leaks and to capture rather than flare (burn) natural gas emissions from oil refining.

Ice cores have revealed that both CO_2 and CH_4 concentrations had been stable for the past 10,000 years, at least until the last two centuries [Schneider, p. 59]. Methane is now 2.5 times as prevalent than it was before the industrial revolution [National Geographic, 5/98, p. 46]. It is now estimated that about 15% of the recent warming has been caused by the rise in methane concentrations. The methane load of the atmosphere has been growing five times faster than the carbon dioxide load since the beginning of the industrial age [N. Geo 5/98 p. 66]. Methane is produced by both natural and anthropogenic sources.

In March of 2004, *Science* [303, 26 March, p. 1953] reported that astronomers in Rome who were studying the atmosphere of Mars had detected the presence of methane. If this observation should be verified it can mean only one of two things. Either the methane dates back to the origin of the planet and has jsut recently leaked out of the interior, or there is life on Mars - bacterial life that is. Methane is produced by bacteria feeding in an anerobic environment.

On Earth, bacteria are engaged in decomposing organic matter in anerobic environments and, thus, are an abundant source of this hydrocarbon gas. Methane is produced in swamps, landfills and in the guts of insects and animals including humans. For example, termite colonies produce vast quantities of methane as do ruminants such as cattle. While humans also produce

about 50 grams of methane per year per person, a cow will produce1000 times as much [Gribbin p. 135]. The concentration of methane in the atmosphere has grown consequent to the growth of human subsistence activities such as cattle-raising, paddy field irrigation (creates artificial swamps), the burning of wood as fuel, and slash/burn agriculture. In total about 70% of the methane in the atmosphere is the consequence of human activities, mostly fossil fuel extraction [*Providence Journal*, 11/28/03]

Methane is also a by-product of the use of fossil fuels. Methane is the main component of natural gas Methane escapes into the atmosphere as part of the natural gas released (usually it is flared off, but not completely destroyed) when oil is pumped out of the ground. Methane also seeps out of coal seams providing a hazard to coal miners; miners call it firedamp because of its tendency to explode [Gribbin p. 136]. Miners carried canaries into the mines as "firedamp detectors" - the canaries would expire from a very small exposure to methane, thereby warning the miners of the danger of explosion.

In 2003, scientists reported that for the first time in 200 years methane levels in the atmosphere have stopped growing. As a methane levels contribute to global warming and to ground ozone and smog this was very good news. However, as noted above increases in the methane burden of the atmosphere were anthropogenic, and so was the recent plateau. Scientists measuring methane levels around the globe found the decrease was predominantly in the latitudes north of 50 degrees - in short either Canada and Russia. The disintegration of the Soviet Union oil and natural gas production declined significantly, and methane emissions declined in tandem. On the darker side, the study found that the decline in Russian emissions was just barely enough to offset increases in methane emissions coming from Asia. As one can safely presume the Asian trend to continue, when oil and natural gas production resumes in Russia we can expect methane emissions to begin rising, and the atomospheric burden to begin rising also [Andrew Revkin, *New York Times*, Nov 23, 2003].

Methane is a saturated organic gas. About 500 Tg yr^{-1} methane is generated globally. As noted, it is evident that 70 % of the total emission has anthropogenic sources. The paddy fields contribute a significant portion, about 20%, of the total CH_4 generated. Livestock, and in particular ruminants, are one of the important sources of methane emission on a global scale. There are two sources of methane emission from livestock: (a) from the digestive process of ruminants, (b) from animal wastes. The estimated value of methane emission from digestive processes of ruminants, in India alone, accounts for 6.47 Tg yr^{-1}, while that from animal wastes accounts for 1.60 Tg yr^{-1}.

There is also some speculation that methane is being released from the warming ocean and tundra regions of the world [Gribbin p. 138]. Thus, we see a very dangerous positive feedback loop emerging.

Good News and the Bad News - The Methane "burp"

In 1997, scientists studying the deep ocean floor from a submarine in the Gulf of Mexico discovered a new life form, a centipede-like worm. These worms had colonized mushroom-shaped mounds of frozen methane. Frozen methane, or methane hydrate, is produced when bacteria feed on organic material in ocean sediments. Combined with a very cold, but not freezing, temperature (8C, 41F or lower) and very high water pressures (over 1500 feet below

the surface), the methane produced by the bacteria is locked into lattice-like crystal "cage" structures made of water molecules. Similar structures are produced in the Arctic permafrost where the cold temperature alone is enough to freeze the methane. It is estimated that there are about 10 million tons of frozen methane in various locations on the Earth which is more than twice the amount of coal, oil and natural gas reserves. It is estimated by the US Geological survey that The US frozen methane reserves of 320,000 trillion cubic feet could, at current rates of use, satisfy the energy needs of the nation for 2,000 years. Since methane is the cleanest of the fossil fuels, it holds the promise of abundant energy, drastically reduced air pollution, and substantive reductions in the emissions of carbon-dioxide, thereby greatly diminishing the threat of global warming and climate change.

The bad news is that these deposits of frozen methane are very unstable. The methane is packed into its "cage" at very high pressures. A piece of methane ice will release about 164 times its volume of methane gas. When either temperature rises or pressure falls, the ice structure fizzles like Alka-Seltzer and dissolves into water and methane. There is some evidence that in the past there have been giant underwater landslides which have destabilized deposits of methane hydrate and may have led to a large release of the gas.

Some 55 million years ago, just after the extinction of the Dinosaurs and just before the emergence of mammals, there was, for some unknown reason, a significant warming of the earth. Over the next few million years, some suggest as a result of the 21,000 year Malenkovich cycle due the wobble of the earth's axis [Richard Kerr, Smoking Gun for Ancient Methane Discharge, *Science*, 11/19/1999, p. 1465] the ocean warmed and warm surface waters were pushed down into the deep ocean. The warming of the deep ocean caused the frozen methane to melt and dissolve into gas. Upon release the methane was oxidized into carbon dioxide. The resultant surge in the atmospheric loading of carbon dioxide caused the earth's temperature to rise by somewhere between 9-12 degrees F. While the warming of the ocean caused the extinction of 55% of the extant marine life, on land the warmer temperatures fostered the proliferation of mammals, including the primates from which Homo sapiens ultimately evolved [Miriam E. Katz. Et al, [1999] *Science* 286:1531-33]. Of more immediate concern, is the possibility that the extraction of methane from the sea floor might destabilize the deposits and result in a release of vast quantities of methane into the atmosphere. Thus, one potentially catastrophic outcome of global warming may be a sudden release of vast quantities of methane gas and a further "spike" in global temperatures. There have been incidents where drilling ships have been sunk and drilling platforms destroyed by the sudden release of vast volumes of methane gas. As one expert put it, the extraction of frozen methane is "horrifically dangerous[43]." The Japanese are developing a site off the coast of Japan and the US Congress is, at present engaged in appropriating funds for the development of US deposits.

The methane "burp" hypothesis given strong support in 2003 when researchers found evidence, off the coast of Florida, of the underwater landslides that "burp" theory predicted. The

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[43] Sudden releases of methane have been offered as an explanation for the mysterious sinking of ships. The methane bubbles to the surface and effectively reduces the density of the water. It is like the ship is trying to float on gas rather than water. Technically, the effective displacement of the ship falls and it sinks. Methane has also been suggested as the cause of mysterious plane crashes. As methane is explosive, a release into the air over the ocean coming into contact with an airplane engine would result in an explosion.

Rutgers University researchers also found evidence of die-off of foraminifera and carbonate sediments that would have been produced by warming of the ocean water and the production of carbonic acid as methane was oxidized, respectively [Kerr, *Science*, 11/19, 2003, p. 1465].

The runaway greenhouse effect

It has been suggested that these vast deposits of methane hydrates might lead to a "runaway greenhouse effect." That is should either human error or rising temperatures destabilize some of these hydrate deposits, the resulting "burp" of methane will cause temperatures to rise, causing further destabilization. Since these hydrates formations contain any where from "several hundred times to several thousand times the amount of methane presently in the atmosphere," the potential for warming is enormous [Evelyn Wright & Jon D. Erickson, Incorporating Catastrophes into Integrated Assessment: Science, Impacts, and adaptation, mimeo, p. 10]. While an interesting speculation, the science conducted until now suggests such a catastrophe is unlikely. About 95 % of these hydrate deposits are under the oceans, and about 5% are in the permafrost. It appears that given the depths at which these deposits are buried under the arctic permafrost (200 meters) and under ocean sediments at depths of 300 to 1000 meters, it would take a considerable warming to destabilize them [Evelyn Wright, *Catastrophe, Uncertainty, and the Costs of Climate Change Damages,* Ph.D Dissertation, RPI, (2000), p.55]. Wright and Erickson report research that suggests that a 6C warming would produce at best further 25% in warming [p. 11]. Once that threshold is passed the risk of catastrophe may be significantly increased, but little study has been devoted to this question. However, there is little chance that such warming will be seen in this century. Finally, even should the "frozen" methane be released some have argued that it would be oxidized into CO2 and dissolve in the ocean before reaching the surface [Wright, 2000, p. 11]. After her survey of the pertinent scientific literature, Evelyn Wright concludes that "a runaway hydrate-climate feedback can be regarded as a very low probability, high consequence event under the range of warming currently predicted to occur in this century" [p. 11].

The West Antartica Ice Sheet (WAIS)

At present, some 3/4 of all the freshwater on earth is frozen in ice that sits on Greenland and Antarctica [Wright, p. 58]. During the last inter-glacial sea levels were some meters higher than today, so naturally scientists are concerned about the possibility of melting of glaciers and polar ice. First, there is concern that the melting ice will cause sea levels to rise. Second, there concern that the infusion of freshwater may affect the thermalhaline circulation that brings warm water from the South Pacific to the North Atlantic. While surely such outcomes would do great harm to people around the world, each pales when compared to the scenario that would follow the disintegration of WAIC.

For many years scientists were concerned that the WAIC, which contains 3.8 million km^3 of ice, might slip off the land, where it is presently ensconced, and into the Arctic Ocean [Wringt, p. 58]. Given the massive amount of ice involved, there would be a catastrophic displacement of water that would result in disastrous (4-7 meter) rise in sea levels around the world [Wright, p,. 58]. This possibility exists because the WAIC sits on land that is below sea

level and is prevented from floating only by dams of rocks and ice. The fear is that global warming may weaken the ice dams and free the WAIC to float on the ocean. The process could take less than a century should the CO2 load of the atmosphere double [Wright, p. 60]. Fortunately, over the past few years scientists studying the WAIC have concluded that it is more stable than previously thought and is in no danger of being destabilized at least up to temperature increase of 6C or within thetimeframe of most economic analyses of climate change [Wrignt, p. 62]. For climate change above 6C, and in the longer -run, the situation is more uncertain.

Global warming or climate change?

The summer of 2003 was a catastrophe in Europe. Due to extreme heat some 35,000 people died. Based on temperature records for the 1990s, scientists at the Swiss Federal Institute, it is reported in *Nature* (Extreme Heat on the Rise, 12 January, 2004), estimated, that under a normal climate regime such a hot summer could be expected no more than once every 46,000 years, *even allowing for global warming.* "Statistically, this event should not have happened," says Christoph Schär, a scientist at the Institute. The issue then was the heat wave a mere "statistical freak" or was it an indication that the probability distribution of weather has become more variable? I n other words, "is global warming a well-behaved process?""

"Weather" can be understood as the normal and somewhat predictable variation in temperature, rainfall, storms and so on inn a given climate. Extreme weather is in the tails of the normal distribution of weather in the given climate. To assert that there has been a change to a "new climate" means a shift in the weather distribution and a change in its variance, i.e. an Increase in weather variability.

In an global warming scenario we expect only that the average global temperature will rise. Climate change, on the other hand, is more than a simple increase in average temperature. Under a climate change regime were expect weather patterns to change with increased weather variability only one such manifestation. More broadly we can expect more intense and frequent storms, droughts, floods and so on. In short, more frequent extreme weather events.

Indeed, rapid climate changes litter the paleoclimate record. Events such as the "Younger Dryas"(a one thousand year period of extreme cold about 8,000 years ago) and the "Little Ice Age" (a prolonged period [1350-1850] of extreme weather and falling average temperatures) reveal how climate can change rather abruptly.

These extreme events are caused by abrupt transitions between different quasi-stable states of atmospheric and ocean circulation that are global in scope. Thus, given such historic patterns of variability, the DICE assumption, "the same only warmer" is overly simplistic. Forecasts of the future must also include the costs of changes in storminess, drought, precipitation, and temperature extremes, ironically including the costs of extreme cold. Such a change is problematic to farmers, insurers, electricity providers, irrigators, those who manage storm infrastructure and so, because their accumulated statistical knowledge of the weather is made obsolete. How can insurers set rates for insurance when they no longer have any reliable information about how frequently extreme storms and floods will occur? The frequency of heat waves will affect the demand for electricity for use in air conditioning. Not knowing how frequent and intense such events will be makes planning for such events little more than guesswork.

Nonlinearity - The worst case scenario

Of all of the projections of the costs and benefits of climate change are based on the assumption that the path of temperature increase over the next century will be linear, moving along at some determined rate as the CO2 (and other ghg) concentration rises. But, as chaos theory warns many natural systems are neither linear or homeostatic. Natural systems have the characteristic of being multi-modal and can quite quickly shift from one mode to another quite quicky, and, given the unpredictability of chaotic systems, unexpectedly. Indeed there is ample evidence that weather is such a system.

In 2002, this was recognized in a report of the National Academy of Science. The NAS pointed to the fact that over the past 100,000 years climate on several occasions has changed modes abruptly, and persisted in the new mode for an extended period of time. The report warns that the change in climate expected over the next century (temperature and variability) might just push the system over a threshold and it will shift to another mode. The NAS ended it report with a warning:

> On the basis of the inference from the paleoclimate record, it is possible that the projected change will occur not through gradual evolution proportional to greenhouse concentrations, but through abrupt and persistent regime shifts affecting subcontinental or larger regions ... denying the likelihood or downplaying the relevance of past abrupt changes could be costly [quoted in Jeremy Rifkin, The Hydrogen Economy, 2002, p. 143]

Greenhouse history

At present the mean global temperature stands at about 15.2C (52F). Some 3.5 billion years ago during what is called the Archean Age, the Earth's temperature stood at a very warm 38C (100F).

During the Archean, life as we know it did not exist. First, the levels of ultraviolet radiation were so high any known life form would not survive long. More significantly, however, there was virtually no oxygen. Virtually all of the molecular oxygen that exists today has been produced over the eons by photosynthesis in blue-green bacteria, algae, and green plants which did not exist during the Archean Age. The Earth terrain consisted of nothing else than treeless, grassless, barren plains, dotted with smoking volcanoes and the seas.

The Earth's atmosphere consisted almost entirely of CO_2 produced by the volcanoes. It is precisely this CO_2-rich atmosphere that accounted for the warm temperature. Indeed, the atmospheric loading of CO_2 was one hundred times the present .035% [Schneider, Laboratory Earth, p. 12]. Thus, during the Archean Age the Earth was apparently warmed by what earth scientist Stephen Schneider has called the "super greenhouse effect." Paradoxically, the amount of solar energy striking the earth during the Archean was considerably less that is received today in the Holocene period. In the Holocene, the sun produces about 600 watts of energy, but in the Archean Age "solar luminosity" was some 25% less because the Sun was quite a bit smaller

then. If solar luminosity should now suddenly decline by 25% the Earth would turn into a frozen ball, not unlike Mars[44]. Hence, we encounter the "faint early sun paradox"- during the Archean there was less solar luminosity, but the Earth was warmer. One obvious explanation is the "super greenhouse effect"[45] produced by the CO_2 in the atmosphere. But, this leads to another paradox. "Why hasn't the Earth overheated over the past 3.5 millions years as solar luminosity increased by 25%?" In other words, "why hasn't the Earth become a superheated desert like Venus" which also has CO_2 - rich atmosphere?"

Earth scientists have proposed that the tendency for Earth's temperature to rise has been moderated by inorganic chemical processes, and biological processes that have operated as negative feedback systems. In other words, as the Earth's temperature rises, both inorganic and biological processes, that have a cooling effect and tend to, thus, moderate the rise in temperature, increase in activity. In both cases, the method of mitigation is the removal of CO_2 from the atmosphere.

At present, relatively little of the carbon dioxide on the earth is in the atmosphere, the remainder is sequestered in rocks in the form of carbonate. If all of the carbon dioxide sequestered in rocks were released into the atmosphere the air would become so heavy the air pressure at the surface would increase from one atmosphere (15lbs/in.^{2}) to sixty atmospheres [Gribbin, *Hothouse Earth*, p. 35]. Just one per cent of the available CO_2 would have been sufficient to keep the Earth warm during the Archean Age [Gribbin, p. 35]. The question is then, "how does the temperature of the earth effect the amount of cabonate and hence atmospheric CO_2 ?" To answer this we must comprehend the carbon cycle.

The Carbon Cycle

Carbon dioxide is water soluble. When CO_2 mixes with rain it forms carbonic acid (H_2CO_3). While a relatively weak acid, it does have, over long periods of time, a "chemical weathering effect" on rocks. Weathering operates independently as an inorganic process, and also biologically, that is, with the interaction of life forms.

In the first instance, the carbonic acid causes minerals such as calcium and magnesium silicates to combine with carbon in the atmosphere to form sedimentary rocks such as limestone and dolomite, and incidentally drawing down the concentration of CO_2 in the atmosphere. In the second instance, the carbonic acid breaks down rock releasing calcium silicates which are compounds of calcium, silicon and oxygen. These compounds ultimately flow into the oceans where they are taken up by plankton and other creatures that have shells, and are turned into calcium carbonate ($CaCO_3$) or limestone. As these creatures die, deposits of calcium carbonate accumulate on the sea floor.

Should rates of rainfall increase, increased weathering will, by both inorganic and organic processes, increase the sequestration rate of carbon and, therefore reduce the amount of

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[44]The atmosphere of Mars is also rich in CO_2, but the atmosphere is very thin compared to that of Earth and Venus.
[45]Carl Sagan and George Mullen at Cornell University, have suggested other greenhouse gasses, such as methane (CH_4) and ammonia (NH_3) were implicated. As these gasses are produced by life-forms, and there were no life forms during the Archean, there has been some criticism of this idea. It is possible that these gasses could have been formed by other than biological forces so the issue remains unresolved. [Schneider, *Laboratory Earth*, p. 11].

CO_2 in the atmosphere. Everything else equal, as the magnitude of the so-called "greenhouse effect" is diminished, the earth should cool.

The Negative Feedback

Should the Earth's temperature tend to rise over time as solar luminosity increased, the carbon cycle would have tended to sequester more carbon, thereby reducing the greenhouse effect. This would have occurred because higher temperatures would have increased evaporation and, higher rates of evaporation would have produced more rainfall. Venus gets about 1.9 times as much solar radiation as Earth, hence, on Venus, the surface temperature is about 500C. If Venus once had oceans, they soon evaporated into space. Venus, unfortunately, was too close to the sun to maintain its oceans. As a result Venus had neither rainfall or oceans to scrub the atmosphere of CO_2. Without this negative feedback, as the sun grew stronger, Venus got hotter, and hotter.

The Gaia Wrinkle

The earth has what one scientist has called an "anomalous atmosphere." The atmosphere on both Venus and Mars, the planets closest to Earth, is virtually all CO_2. The atmosphere of Earth is primarily nitrogen (78%), and Oxygen (21%) and only .035% CO_2. It is then not unreasonable to ask "how did this anomalous gas cover of the earth form, and what is the mechanism that controls this strange gas mixture?" [E. Mezaros, *Atmospheric Chemistry*, p. 18]. One factor is the serendipitous position of Earth relative to the Sun. Had the Earth been only 6% closer to the Sun, it would have had a superheated CO_2 atmosphere just like Venus [Mezaros, p. 18, n.1]. Secondly, should the earth have had less mass, it might have turned into a frozen planet like Mars. Were it not for such serendipity, life on earth, the biosphere, may not have evolved to play its most important role in governing the composition of the atmosphere

The Gaia theory asserts that biological processes are part of a homeostatic mechanism that tends to regulate the temperature, chemical composition and other aspects of the Earth's atmosphere, in short, "life wields active control over the planet's environment."[Schneider, p. 14]. Some very respectable scientists have argued that just such a mechanism could explain the "faint early sun paradox."

If, in the face of increasing insolation, global overheating was to be prevented, some mechanism had to scrub the atmosphere of CO_2. Rising temperatures surely would have contributed to this goal through the carbon cycle, but this is an inorganic process. The Gaia argument is, essentially, that the presence of life on earth contributed to sequestration of CO_2 . The leading Gaians, Lynn Margulis and James Lovelock, contend that algae, which have been in the oceans since the beginning of life, and more recently (about two hundred million years ago) phytoplankton, have functioned to scrub the atmosphere of CO_2 by turning it into carbon-based materials such as stromatolites[46] and shells. Critics of Gaia claim that the role of life in

[46]These are mushroom-shaped rocks that date back at least as far as the Precambrian period. Some have been dated at 3.5 billion years old. If, as it has been assumed, that these formations were biogenic in origin, it would follow that life on earth was at least 3.5 billion years old. As we have noted, the conditions for life were not yet present in the

regulating the atmosphere had to wait until inorganic forces cooled the earth sufficiently to allow bacterial life to exist. Then, over several billion years of biological evolution culminating in the efflorescence of plants a few hundred million years ago, the growing effects of biological factors withdrew CO_2 from the atmosphere and terminated the "super greenhouse effect"[Schneider, p. 15]. Were it not for the presence of life on Earth, Margulis and Lovelock contend the atmosphere of Earth would be like that of Venus, practically pure CO_2 and Earth would be 60C warmer than it is now [Schneider p. 14].

The Carbon Cycle revisited.

In our discussion so far we have examined only how carbon is removed from the atmosphere, but, if we are going to have a "cycle" carbon is also recycled back into the atmosphere. Indeed, the sequestered deposits of calcium carbonate will eventually be released back into atmosphere. The carbonate sediments on the ocean floor are forced under the continents by tectonic action where they eventually melt, and release carbon dioxide. The carbon-cycle is completed when the carbon dioxide is released back into the atmosphere during volcanic eruptions. One of the main reasons why Mars is frozen is that, due to it lesser mass, its core cooled faster than Earth's and thus volcanic activity ceased early in the planet's history. Over time then, rainfall and weathering removed CO_2 from the atmosphere, but it was not replaced by vulcanism, so the planet got colder and colder as the greenhouse effect weakened [Gribbin p. 38].

As the activity of volcanoes is hardly regular, the amount of carbon dioxide in the atmosphere will vary over time. In times of great volcanic activity the atmospheric loading of CO_2 will rise causing a warming of temperatures and vice versa. Since vulcanism is also related to tectonic activity, variations the latter may also help explain the cycles of temperature that have been observed over the millennia.

The mid-Cretaceous period (100 million years ago), for example, was a period of very active undersea vulcanism. This volcanic activity not only increased the amount in the CO_2 atmosphere, but by filling in the sea floor, it caused sea levels to rise. In the Cretaceous, land constituted only 20% of the Earth's surface compared to 30% today [Schneider, p. 41]. This relatively wet world was also about 10C (18F) warmer than it is today and about as warm as it has been in the past three billion years. We find fossils of broadleaf plants and alligators from this period near the Arctic Circle. Of course, the most well-know fauna of the Cretaceous, were the Dinosaurs. That's right, the Cretaceous not the Jurassic.

The high levels of carbon dioxide provided by volcanoes, which promoted photosynthesis, and the warm temperatures led to a proliferation of broadleaf vegetation. The wet environment produced more water vapor[47] (a greenhouse gas), but provided also many anoxic locations for dead organic material to accumulate, and, hence fossil fuels were created in

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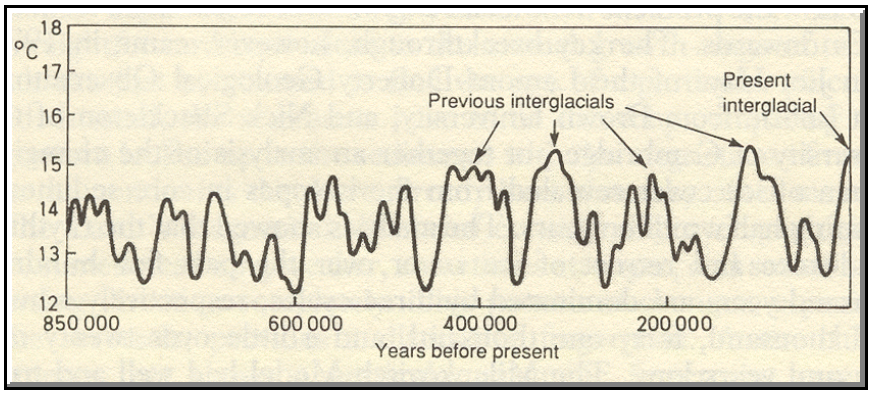
Archean Age. Hence, some have doubted that these formations were true fossils, arguing instead that their morphogenesis was due to inorganic forces. If so, the Gaian assertion that organic processes, i.e. life, is crucial to maintenance of the atmosphere is clearly counterfactual.

[47]Water absorbs more solar energy than land because it is darker. Second, as a the surface area of water increases there is more evaporation.

great quantities. For example, a great deal of America's coal deposits are found where there was, during the Cretaceous period, an inland sea that divided eastern and western North America. This inland sea also explains why we find fossilized clams in the foothills of the Rocky Mountains [Schneider, p. 42].

As relatively warm as was the Cretaceous, so was the period, some 300 million years ago, between the Permian and the Carboniferous relatively cold. In this period as well we find the pervasive advance of land plants and their deposition into what would eventually become coal deposits. The carbon that we burn today was scrubbed out of the Carboniferous and Permian atmosphere by plant photosynthesis. The consequent reduced greenhouse effect "likely had a major influence in bringing about the Permian-Carboniferous glaciation, the most extensive and the longest glaciation in the past 570 million years. Thus, the experience in both the Cretaceous, and the Permian-Carboniferous periods, "support the idea that the atmospheric greenhouse effect has been a major factor affecting global climate change over geologic time."

In 1988, a group of researchers which had studied deep ice cores extracted form Greenland, and Vostok in Antarctica (about the coldest place on Earth) reported that the amount of methane in the atmosphere during past two interglacial periods was double the level during



Source: US National Academy of Sciences, reprinted in Gribbin, Hothouse Earth, p. 54

the previous ice ages (.62ppm v.34ppm). Since methane is almost totally produced by the biological activity of bacteria, these observations indicate that the bacteria either became more active as the Earth warmed, or a warmer, wetter earth provided more swampy areas for them to inhabit. In either case, the activity of the bacteria provided a positive feedback; as the earth warmed the bacterial forces produced more of the greenhouse gas methane thereby enhancing the greenhouse effect and exacerbating warming [Gribbin, p.64]. The same ice cores also revealed that the amount of CO_2 in the atmosphere during the Ice Ages was 30% below the levels found in the interglacial periods (190 ppm vs. about 280ppm[48]) and there was only about 50% as much methane [Schneider, *Laboratory Earth* p. 55, *Global Warming* p. 41]. These observations suggest the existence of a positive, rather than negative feedback system between

[48] 280ppm is the level that persisted before the industrial revolution. At present the concentration of carbon dioxide is about 350ppm.

climate and these greenhouse gasses [Schneider, p. 55]. As the earth began to warm the concentrations of these gasses tended to rise, promoting a further rise in temperature. More importantly, however, it appears that the changes in CO_2 levels preceded the changes in the climate [Gribbin, p. 60].

It would appear then that ice ages come to and end because of an increase in the potency of the greenhouse effect caused by increased atmospheric loadings of CO_2 and CH_4 (methane). The question is then, "what caused the intial increase in temperature that caused the amount of CO_2 and CH_4 (methane) to increase?" One possible answer is answer is the Milankovich cycle.

The patterns of cooling and warming revealed in the ice cores reveal the patterns expected from the Milankovitch cycle[49]. But, there is a slight difficulty presented by the degree of the temperature changes and the relatively small changes in temperature one would expect from the Milankovitch cycles. The fact is the Milankovitch cycles do not alter the total amount of heat the earth receives from the sun, but rather as Gribbin writes, "the three astronomical cycles only redistribute heat between the seasons, and they do that by a very modest amount." One can easily see in the figure above that the periods of warming that characterize the 100,000 year cycle are rather dramatic. The question remains how could the relatively small seasonal effects produced by the Milankovitch cycles produce such substantial changes in global climate? It would appear that the small changes initiated by the astronomical cycles initiate, in turn, the operation of several positive feedback systems, including the CO_2 and CH_4 systems noted above that tend to produce more dramatic temperature changes. About one half of the warming that ended the last ice age (2.2C out of 4.5C) can be explained by the increasing atmospheric concentrations of CO_2 and CH_4 [Gribbin p. 64].

Those who hope for some type of Gaia force to impede the increase in temperatures as human activities add to the atmospheric loadings of greenhouse gasses have to confront the "evidence of the ice" [Gribbin p. 68]. If anything, biological forces, do not resist, but rather exacerbate the tendency of temperature to rise or to fall depending on the event that initiates the perturbation to the system. Some 11,000 years ago at the end of the last ice age, the "evidence of the ice" reveals a temperature increase of 6C in just forty years [Gribbin p. 68].

Some negative feedback - Dust, Plankton & Clouds

The next time you go to the beach and take a deep breath of the "sea-air" you should note that what you are actually smelling is dimethylsuphide (DMS), a waste-product of the micro-organisms that live near the surface of the ocean. Ice cores taken at Antarctica indicate that as much as five times DMS was being produced by these creatures during the last Ice Age than at present. DMS, in turn, reacts in the atmosphere and droplets of sulphuric acid are the result. Water droplets and ice crystals attach to the sulphuric acid droplets and form clouds. These

[49]Ice cores that record temperature changes over the past 800,000 years reveal three cycles respectively of 100,000 years, 41,000 years, and 21,000 years. Of course, as these patterns are not coincident, that is, at any point in time each cycle is in a different phase (like the Aztec calendar), every cycle is slightly different. These cycles would produce the same pattern only every several billion years. These cycles explain about 80% of temperature variance over this period. The puzzle come from the fact that the dominant 100,000 cycle can account for, at most, a .1% change in insolation (solar energy hitting the earth) which would seem hardly enough to cause either the beginning or the end of an ice age [Gribbin p. 54].

droplets of sulphuric acid then are the "seeds" from which clouds grow.

Scientists have observed that as coal burning ships crossed the Pacific Ocean, clouds seemed to follow the same path. It appears that the sulphur dioxide produced by burning coal produces the same sulphuric acid droplets as DMS [Gribbin p. 66] and both result in cloud formation. Clouds, in turn, reflect sunlight back into space and hence cool the earth. Thus, the expansion of the population of plankton both reduces the amount of CO_2 in the atmosphere and increases cloud cover -both of which, everything else equal, cool the earth. There is, however, a natural limit to this process for, as clouds reduce the amount of sunlight, the ability of the plankton to do photosynthesis is inhibited. As the cooling effect is determined by the biological activity of the plankton, and the latter is determined by, among other things, available sunlight, the cooling effect damps out.

It is now well established that iron is a key factor in determining the size of the plankton population. While the oceans seem to be rich in most nutrients (phosphates and nitrates) needed by plankton to grow, a deficiency in iron limits the plankton population. Experiments have shown that adding iron to oceans would lead to an substantive increase in the plankton population. Which gets us to dust.

Ice core studies have found that during ice ages there was more dust in the air. With so much water contained in ice, the earth is dry and dusty. Consequently, dust is blown into the oceans and, fortunately for the plankton, dust contains iron. The iron stimulates growth of plankton until it exhausts the supply of some other nutrient (the studies say nitrogen). Once again the cooling effect of the expansion of the plankton population comes to a natural end.

Thus, should an increase sunlight say from the operation of a Milankovich cycle tends to warm the Northern Hemisphere, the growth of plankton stimulated by the increased sunlight, will work in *a negative feedback fashion* to reduce sunlight and to cool the earth.

Deforestation-The burning reason

Trees which absorb CO_2, are a major defense against rising CO_2 concentrations in the atmosphere. Climatologist Stephen Schnieder estimates that deforestation accounts for half of the increment in atmospheric carbon dioxide since 1800 [NG 5/98 p. 64].

The Amazon rainforest is the largest tropical forest in the world and the part that lies in Brazil is equal to about ½ of the area of the continental United States Larry Rother, Deep in the Amazon, Vast Questions About Climate, *New York Times*, 11/4/2003]. While the Brazilian rainforest is usually assumed to be the world's largest terrestrial carbon sink, it is still an open question as to whether the forest actually absorbs more carbon than it releases. In 1995 scientists found that each 2.5 acres of Amazon forest sequestered about nine tons of carbon - a number that seemed unreasonably high enough to force scientists to question both their instruments and their methodology [Rother, *New York Times*, op. cit.]. By any measurement, the forest was simply not growing fast enough to justify such a figure [Rother]. Since then estimates have been revised downward to about 1 ton per 2.5 acres which implies a scrubbing of some 100 million tons of carbon per year [Rother]. At present a cooperative effort of Brazilian, European and American scientists is attempting to get a more reliable measure of the net emissions of the Amazon. It is important to note that these studies are of an equilibrium where a fixed area of the forest is untouched. Whatever the scrubbing capacity of the forest per acre, it will be reduced as the

number of acres falls due to deforestation.

It should be stressed, then, that there is little little doubt that the pattern of land use changes in the Amazon over the past few decades has resulted in massive releases of carbon into the atmosphere. By 2001, some 10,000 square miles of Amazon forest had been burned and converted to alternative uses (e.g. cattle, soybeans, small farms). One third of its trees have been cut to clear land for agriculture, to make pasture or to make charcoal for energy [Nat. Geo 5/98 p. 63]. The cutting of the Amazon rainforest, primarily to raise cattle (Brazil has an average of 160 million head of cattle compared to the US which has 198 million head), and other forests around the world is alleged to be exacerbating the greenhouse problem.

First, the burning of the forest is releasing vast amount of CO_2 (net 1 to 2.5 billion tons per year) into the atmosphere [Ehrlich & Ehrlich p.75]. The annual burning of the rainforest in Brazil emits more pollutants than the economies of Poland and Germany combined [Revkin p.296]. Second, it has been estimated that the burning of biomass (tropical rainforests) is adding about fifty million tons of methane to the atmosphere each year [Gribbin p. 137]. In Brazil, some 400 million tons of carbon are added to the atmosphere each year due to land use changes.

Adding the 90 million tons produced by its burning of fossil fuels, places Brazil among of the world's top ten producers of greenhouse gasses [Rother, *New York Times, 11/4/2003*]..

Rainforest Fires

Natural fires caused by thunderstorms, solar radiation or more recently by human activity have always been present on earth. Well known examples are the periodical wildfires of African savannas, bush fires of Australia and fires in boreal forests of Canada, and Siberia. These ecosystems are in ecological balance with fire and are well adapted to fire's impact.
Over the past several decades, forest fires have become a serious problem to ecosystems not adapted to fire. Most notably, in tropical rainforests, fire has been very infrequent, occurring during extreme climatic conditions like El Nino. For many millennia, humans have used fire for land clearing in tropical rainforests (swidden) without having a major impact on this ecosystem. However, a growing farming population, and other economic interests have made the rainforest highly susceptible to fires. Current land use practices like logging and large scale land clearing or accidental fires disturb the microclimate, and both increase the fuel load and fire intensity. The change of the global climate further exacerbates this risk by producing extended droughts.

Rainforest fires have emerged as one of the biggest environmental issues of the last decade," says ecologist Dan Nepstad of Woods Hole Research Center in Massachusetts [Nature, Science Update, Nov. 22, 2001]. In addition to the devastating effects on flora and fauna, these fires endanger human health, and "the carbon released from large forest fires could negate the decreases in carbon emissions that the Kyoto Protocol demands. Rainforest fires could easily counteract the reductions."[Nature, Sceince Update, Nov. 22, 2001].

Between 1997 and 1998 El Nino caused a drought that triggered rainforest fires worldwide. In the area around Indonesia rain forest fires have become so extensive that the region becomes covered with a suffocating haze. The air pollution index safe at about 50, regularly hits 300 and sometimes 500. The fires are caused by open-burning activities carried

out by plantations and farms. Under normal conditions, these fires can be controlled, but when the region is dry, the fires burn out of control, sometimes for weeks. In the rainforest of Indonesia in 1997, a fire, considered to be the worst ecological disaster ever to hit Southeast Asia, raged out of control, threatening endangered species and habitats, and the health millions of people.

In 1997, in the Amazon region of Brazil, forest fires burned out of control. Smoke from these fires forced the closing of airports and schools in distant cities, and in Manus, "the sun disappeared for days at a time" [Diana Schemo, Rising Fires Renew Threat to Amazon, *New York Times,* 11/2/97]. The fire that has been burning in the Amazon region of Brazil now threatens the Stone Age Yanomami Indian tribe deep within the rain forest. The northern state of Roraima''s savannah highlands has now been burning for two months. The drought-ridden Mucajai River separates the fire from the Indian village. If the flames jump the river, they could potentially consume the entire forest. The fires have been blamed on a drought caused by the El Niño weather phenomenon, and the Yanomami's tradition of clearing jungle by using the slash-and-burn technique. So far, the fire has burned 1.5 million acres, or about three percent of Roraima. The fire now threatens the 25-million-acre reservation, home to some 9,000 "stone-age"Yanomami Indians.

All indicators suggest that the fires in Amazon are worse than those in Indonesia which, in 1997, covered a good part of Southeast Asia with smoke, and knowledgeable people worry that the Amazon is on the verge of "catastrophic fire events, with potentially enormous global consequences [Schemo, op. cit.]. Obviously, these fires release vast quantities of smoke, methane and carbon dioxide into the atmosphere, and reduce the effectiveness of the rainforest as a sink for carbon. .Recent field studies show the burning of standing forest can release 10 to 80 percent of forest biomass to the atmosphere as heat- trapping carbon dioxide [Environmental News Service 1998].

More subtle, however, put perhaps more devastating is the fact that these fires are changing rainforest ecology. Christopher Uhl, an expert of tropical fires from Penn State, observes that "fire adds a whole new dimension to tropical disturbance ecology." Uhl views fire as an monumental force for change in rain forest ecosystems. "Even for those species that survive, these grand fires might be among the largest biological selection events in modern history."[quoted in Susan Milius**,** Amazon forests caught in fiery feedback: research indicates small forest fires make Amazon rainforests susceptible to more destructive blazes, *Science News*, Oct 3, 1998]. In 1997, it is estimated that fires consumed 7,800 square miles of the Amazon rain forest and threatened to turn the Xingu National Park, home of 5000 indigenous people, in to a blackened wasteland [D. Schemo, New York Times, 9/13/1998].

In temperate forest ecosystems, fires are normal and even salutary events. Regular fires prevent the accumulation of combustible materials and greatly reduce the chance that any fire will burn hot and become a truly damaging "crown fire." "Little fires lap up dead leaves and branches, preventing fuel from building up, and adaptations like thicker bark protect trees. Forest managers now set these so-called prescribed burns as preemptive housekeeping blazes."[Milinus, op cit]. Fire, however, is not a normal feature of the "damp, humid rainforest" [Phillip Boffey, *Penetrating the Remote Amazon Rain Forest*, New York Times, 8/21/2000]. Destructive fires occurred in the Amazon only rarely, every 400 years or so, and only when the forest had been desiccated by an extended drought, such as those produced in an El Niño.cycle [Boffey, op.

cit.].

For example, a typical dry spell lasts about 16 days, during which some 5 percent of a rain forest will become dry enough to burn. The fire will usually be modest ground-creeper, but it can damage the canopy. One year after such a fire has burned through a forest, the canopy provides only 60 percent shade instead of the normal 85 to 95 percent [Mark Cochrane, (Woods Hole) and Mark D. Schulze (Penn State), quoted in *Milius, Science News*, Oct 3, 1998]. "Even a small fire can sufficiently tatter the shade canopy --and leave behind enough extra debris for fuel--to render some 50 percent of that forest vulnerable to a second, more destructive fire during a subsequent dry spell. As fires recur, virtually all the forest becomes susceptible." [Mark Cochrane, (Woods Hole) and Mark D. Schulze (Penn State), quoted in *Milius, Science News*, Oct 3, 1998]. Thus, the increasing frequency of fires has created a positive feedback system where one fire makes another, not only more likely, but more damaging [Cochrane, M. et al. Positive feedbacks in the fire dynamics of closed-canopy tropical forests. *Science,* 284, 1832 - 1835, 1999].

The problem in made even worse by logging of hardwoods, most of which is illegal, and is completely rampant and uncontrolled. Like fires, logging thins the canopy allowing the penetration of desiccating wind and sunlight. When selective logging takes out a choice tree for timber, others are felled as it falls, leaving flammable wood on the ground. This, and road construction for timber transport, punch large holes in the forest's dense canopy which let in the sun and dry out the scrub beneath. Ground fires then become much more destructive. Flames, usually only 1 or 2 meters high, reach up to 15 meters in logged areas. And one fire increases the risk of another by leaving partially burnt firewood in its wake. Rainforest fires start when fires used to clear land for grazing or plantations get out of control, but over-logging exacerbates the problem. "Burning and logging on the same landscape is a recipe for disaster," asserts, Mark Cochrane of the Basic Science and Remote Sensing Initiative in East Lansing, Michigan [*Nature, Science Update*, Nov. 22, 2001]

Because El Niño, has always been there, it cannot explain the increasing frequency of fires in the Amazon rain forest. The source of this new threat to the Amazon and the global ecosystems is an increasing human presence in the Amazon. The Amazon has been invaded by the starving masses of Brazil's urban slums, and its most powerful corporations. In order to clear land for farms and corporate cattle ranches, the invaders simply set fires. As destructive as these fires might be to the local area, their potential impact is far greater, as each fire makes a greater and more intense fire more likely. Under the appropriate "initial condition" of a severe drought, a single fire set by an impoverished farmer could literally set off a fire storm that might consume millions of acres of forest, and cover the earth with smoke. While surely, no "nuclear winter," such an scenario is grim to say the very least.

Recently researchers have focused on the effects other gases, especially, methane

(CH_4)[50] might have on global warming. Some scientists have noted that methane may interact with CO_2 in a way that increases the greenhouse impact of CO_2. The atmospheric loading of methane has doubled in the past 150 years with most of the increase coming since 1950 [Ehrlich & Ehrlich p.76].

All over the world, forests that absorb CO_2 and produce oxygen, are disappearing at the rate of 100 acres per minute. The US imports enough lumber from tropical rain forest each year to cover the state of West Virginia. Central and Latin America forests are being cut down to pasture cattle. Only about 20% of Central America's seasonal rain forest remains [Ehrlich & Ehrlich p. 165] In Indonesia ½ million acres of rain forest cut down each year to produce toilet paper for North America. US pacific old growth forest (redwood and Douglas Fir) are logged for export to far east. The Japanese are cutting down part of the Malaysian rain forest to make disposable chopsticks [Merchant 1992 p.21]. The demand for wood as fuel is in the process of deforesting India and turning it into the "biggest desert in the world." The deforestation of the Himalayas is no doubt related to catastrophic flooding in India and Bangladesh. The same story applies in much of the developing world. 2.5 billion people depend on fuel wood for cooking and their quest for it is threatening forests everywhere in the third world [Ehrlich & Ehrlich p. 166].

CFCs

CFCs are better known for their effect on the ozone layer, but CFCs are far more potent greenhouse gasses the either methane or CO_2 as they provide some 4000 times more "radiative forcing" per unit of mass than CO_2 [Cline p. 18]. Atmospheric concentrations of ozone have been rising at 4% per year. However, since CFCs are destroying ozone, a greenhouse gas, the buildup in CFCs has been "neutral in total radiative effect" [Cline p. 19]. This finding has placed the United States in a politically awkward situation. The US had taken the position that it would meet its "quota" for reducing greenhouse gasses by reducing CFCs. Now that CFC reduction is known not to be a potent source of warming, the US must now find other ways to meet its commitment [Cline p.19] CFCs are still a problem, however, because the destruction of ozone, as we shall se below has other deleterious environmental effects.

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[50] Methane is produced by anaerobic respiration of anaerobic bacteria. Moist places where oxygen is not present are an ideal place for anaerobic bacteria: rice paddies, landfills, swamps, and the guts of ruminant cattle and termites [Ehrlich & Ehrlich p. 76]. Right now the EPA is doing experiments to measure how much methane is released when cattle belch and pass wind.

A Negative Feedback System

Biogenic emissions of sulphur from oceanic phytoplankton may play a role in global climate regulation. When ocean water is warm, tiny, single- celled organisms release dimethylsulphide (DMS) that is oxidized to SO2 and then to SO4, in the atmosphere. Acting as a cloud droplet condensation nuclei, these sulphate aerosols increase the Earth's albedo (reflectivity) and cool the Earth. As ocean temperatures drop because less sunlight gets through, phytoplankton activity decreases, DMS production falls and clouds disappear. Thus, DMS, which accounts for half of all biogenic sulphur emissions, could be a feedback mechanism that keeps temperature within a stable range for all life - [Cunningham & Saigo, Environmental Science 4th ed. p. 64]

The burning of fossil fuels also produces a smog called sulfate aerosol that increases the albedo and thus had a cooling effect

In 1990, the Intergovernmental Panel on Climate Change (IPCC), a group of 200 atmospheric scientists predicted that there is a 50-50 chance of a temperature increase of 3 to 10 degrees F by 2050, a sea-level rise of between 3-12 inches by 2030, and that inland areas will be drier in the summer [Ehrlich & Ehrlich p. 107]. These predictions are based the logical or theoretical impacts of "greenhouse" gasses on world temperatures, but it is not decisively clear that they have had any measurable impact. World temperatures follow cycles and many other events, such as erupting volcanoes[51] can influence them. How doe we separate the systematic effects of greenhouse gasses from these other random effects? The best we can do is make probabalistic statements. Moreover, there are many so-called negative (or stabilizing) feedbacks in ecological systems that could mitigate the effects of more CO_2 emissions and these are included either imperfectly or not at all in the climate models used to make the IPCC predictions. For example, as the temperature rises more clouds are created which will tend to cool the planet back down [Bailey 153]. The oceans and plants appear to absorb a great deal [about 1/2 according to

In June 1991, Mt. Pinatubo erupted producing a "large transient increase in stratospheric aerosols." Over the next two years these aerosols produced a negative radiative forcing of that peaked at about about $4Wm^{-2}$ and averaged about $2Wm^{-2}$ for two years. This effect is much larger than even the decadal effect of greenhouse gas forcing which is only $.4Wm^{-2.}$ As a result the earth cooled by about .4C, about as much as the greenhouse effect had warmed it over the preceding century. But, the effect of the aerosols was transitory and the upward trend in global temperature resumed late in 1992.
IPCC(1994)Climate Change 1994: Radiative Forcing of Climate Change and an Evaluation of the IPCC IS92 Emission Scenarios, edited by J.T. Houghton et al, Cambridge University Press1995, p. 13, 189

[51] In a paragraph that is not exactly clear, Balling [1995] claims that volcanic dust played a role in producing the observed increase in world temperatures. He claims that one-third of the observed rise in temperature can be explained by changes in volcanic dust over the period. Since volcanic dust cools by blocking sunlight we must presume that dust levels declined over the period. The eruption of Mt. Pinatubo undoubtedly contributed to the global cooling in the period after 1991 [Balling 1995 p.94-96].

Ehrlich & Ehrlich p. 75] of CO_2, as the oceans warm exploding populations of algae may absorb even more CO_2 [Bailey p.144, Louma p.57]. Also while the Brazilian rain forest is shrinking, the forest cover in the United States and in Russia are expanding [Bailey 144, NY Times 11/1/97]. Finally, there is evidence that rising levels of SO_2 are having a cooling effect.[52] Since SO_2 is now targeted for reduction because it causes acid rain, this cooling effect may be lost in the future [Cline p. 25]. Skeptics note further that the simulation models climatologists use to make predictions of world temperatures as CO_2 loadings rise, by failing to take these mechanisms into account, overestimate future global warming.[53]

On the other hand, there is the possibility of positive (destabilizing) feedbacks. Rising temperatures will raise the amount of moisture in the atmosphere and moisture is the number one greenhouse gas. Also, a warming of the permafrost could release more methane. Finally, as the earth warms humans will use more air-conditioning adding more heat and CO_2 to the atmosphere [Louma p. 57]. It is easy to see the complexity that climate modelers have to contend with and why many may legitimately question the IPCC projections. According to one poll of atmospheric scientists, most scientists (53%) assert that greenhouse gasses have had no effect on world temperatures and many (30%) claim they simply do not know. Only 17% believe that global warming has begun, that is, we are on an upward trend related to the "greenhouse gases" as opposed to the upward segment of a natural cycle [Bailey 156].

If we grant that global temperatures have risen since the industrial revolution, then the data present something of a conundrum if we use the CO_2 loading as the explanatory variable. In the 113 years between 1881 and 1993 global temperatures rose by .54 degrees centigrade while the CO_2 load rose 40%. However, 70% of the increase in temperature occurred in the first half of the period while the bulk of the CO_2 increase occurred in the second half (after WWII) [Balling 1995 p. 91]. Moreover, the climatological models now in use to make predictions of warming indicate the temperature should have risen 1.0 degree centigrade [Balling p.91] If looking backward the models overpredict by a factor of two, one can legitimately wonder how much they overpredict looking forward. One the other hand, the GCMs are now taking better account for negative feedbacks such as those caused by air pollution (increased levels of sulphur dioxide and ozone stripping by CFCs) that may have accounted for a masking of warming and consequently, the overpredictions by the models.

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[52] Sulphur dioxide produces aerosols that reflect sunlight, brighten clouds and extend the lifetime of existing clouds [Balling 1995 p. 89]

[It] In 1995 both American and German scientists have added the effects of "sulphate aerosols" to their Global Circulation Models. The new simulations track past weather patterns much more closely than in the past. Projections of future warming using the new models have not been made public at this time. One would presume the projections would be less alarming than those in the past [Providence Journal 11/26/1995 p. D2].

The Kyoto Agreement.

In 1997, 160 representatives of many nations met in Kyoto, Japan to work out an agreement on global emissions of carbon dioxide. The thirty-eight developed nations in attendance signed the protocol agreement, The underdeveloped nations did not sign the agreement. The IPCC had recommended a 20% reduction in emissions. The delegation from the European Union proposed that emissions of carbon dioxide be reduced, by 2010, to 15% below the level measured in 1990. Due primarily to the efforts of the United States, that is, the Clinton Administration, the final agreement settled on 7% reduction by 2012[54].

The Clinton Administration announced its intention to sign a global treaty to reduce emissions of ghgs on Earth Day, April 1993. He then began "waffling and backpedaling" and, late in 1993 produced a plan that would be based on voluntary efforts of industry [Rampton & Stauber p. 284]. In 1997, Clinton announced that efforts to reduce emissions should be pushed back twenty years, prompting one observer to claim he could hear champagne corks popping in the boardrooms all over corporate America [Rampton & Stauber p. 284]. During the Kyoto negotiations the US representative lobbied strongly for reduction of the target to 7% by the year 2012. Also, at the behest of the Clinton Administration, the developed nations could avoid reducing emissions through the purchase "right-to-pollute credits" from developing nations that exceeded emission reduction targets. The latter point was made moot when the agreement failed to get the signatures of a single developing nation. The treaty had strayed so far from what the IPCC recommended that Greenpeace called it a "tragedy and a farce"[Rampton & Stauber p. 284].

Representatives of the developing nations such as China, refused to sign such an accord as doing so would inhibit its future growth[55]. The U.S. Senate then refused to accept any treaty not signed by China and other developing nations. Clinton made it know that he would not submit the treaty to the Senate for ratification until the developing nations signed it. Then, in 2001, President Bush repudiated the treaty altogether, saying it would be too costly for the increasingly vulnerable American economy to cut emissions of carbon dioxide. Other nations, most especially the Europeans, were appalled at the apparent arrogance of the United States that would allow it to be so diffident to the interests of the other nations in the world.

But, as usual, the picture is not quite so clear. Surely, the people of Europe have a far more refined "green" sensibility than Americans, and have acted aggressively toward many environmental problems. Nevertheless, there was not a little cynicism in Europe's setting such a high standard for emissions reduction. In the case of Germany, for example, the modernization of East Germany's obsolete and inefficient power generating system, which needs to be done in any case, would go a long way toward meeting the emissions reduction standard proposed in

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[54]Not all countries faced the same requirement. The EU settled on 8%, and Japan 6%. Some countries such as Australia, Iceland and Norway were allowed to increase emissions. On average, the agreement would require a 5.2% reduction in emissions.

[55]China signed the accord in 2003, but is still not obliged to reduce emissions. By ratifying the accord, China became eligible to participate in the Clean Development Mechanism, a means by which it is able to get foreign financial support for any project that reduces emissions of ghgs. The supporting countries get credits toward their domestic emissions.

Kyoto.

Germany, as the largest emitter in the EU, has long recognized the need to reduce GHG emissions. It has taken on the responsibility for the largest reductions: 252 million metric tons (mmt), equivalent to a 21 per cent reduction between 1990 and 2008/12. While action in Germany has been taken nationwide, the improvement in the German position to date, a reduction of about 17 per cent in GHG emissions from 1990 to 2000, largely reflects the dramatic decrease in emissions from the former East Germany.

Germany, ironically, like many other nations, continues to subsidize coal use. According to the Worldwatch Institute, Germany spends about $21 billion dollars each year to keep the price of coal to consumers below the cost of production and the market price. The purpose of this subsidy is to protect coal-mining jobs in some high unemployment areas (Rhur and Saar) and security of supply. It was estimated that the reduction in the subsidy would result in the loss of 55,000 mining jobs and another 70,000 jobs in coal-related supply industries. Oddly, as the subsidy amounts to about $70-80,000 per job per year, it would be cheaper to shut down the mines and just pay the miner salaries. When the government announced recently that it was going to scale back the subsidies, there was an enormous protest, a strike of miners, and a siege of the capital in Bonn. After a great deal of negotiation, it was agreed that there would be an "orderly shrinking" of the hard-coal industry, that is, in the interest of "social peace" the subsidy would be reduced by 50% over a ten-year period ending in 2005 [www.eurofound.ie/1997/03/features/de9703104f.html].

Germany is not the only nation that subsidizes coal production. Around the world some $63 billion is spent to protect coal mining - $30 billion in the industrial nations and $27 billion in the former eastern bloc countries and $6 billion in China and India. While still a large user of coal, China has cut coal subsidies by half since 1984 accounting for a 5.2% reduction in coal use by 1998. China is particularly focused on reducing coal use in cities and has banned high-sulphur coal. Over the past five years, China has eliminated over 870,000 coal miner jobs and in 1999 had plans to close 25,800 coal mines [www.worldwatch.org/alerts/990825.html]. Nevertheless, China will continue to rely heavily on coal to produce electricity.

Similarly, the United Kingdom has historically had a high per capita level of GHG emissions. It has accepted a reduction of 12.5 per cent between 1990 and 2008/12, and has adopted a national target of about double this percentage. The UK has already achieved a 14.6 per cent reduction in ghg emissions, due primarily to substantial fuel switching from coal to natural gas. [Pew Center on Global Climate Change]. Between 1980 and 1994 coal production in the UK fell by 60% compared to 40% in Germany. Consequently, while in 1978, there were 1.2 million coal miners in the UK, by the year 2000 only 12,000 remained. England, under Thatcher was much more forceful in removing coal subsidies than were the Germans. Between 1900 and 1995, as the nation switched to cleaner natural gas, the UK cut subsidies to coal by 91%. By way of contrast, in 1994 US coal production was 25% higher than it was in 1980.

For the European Union, the eventual incorporation of East European nations like Poland and Hungary, who must also modernize their power industry, will allow the standard to be met even as the rest of Europe increases emissions [Eugene Linden, New York Times, 9/27/97]. England, in turn, since the time Margaret Thatcher has embarked on a policy to replace coal, and not insignificantly, recalcitrant unionized coal-miners, with natural gas and oil from its newly developed North Sea fields. As all of this is water under London Bridge, the additional cost of

meeting the Kyoto standard will be small or nonexistent. This is not to say that the US does not need to reduce emissions, after all, it now produces 25% of global carbon-dioxide emissions, yet at the same time, the Europeans have no grounds be so smug and morally superior. Their contribution to emissions control while significant, and unavoidable, has cost them little. Indeed, the move from coal to other energy sources, given the huge subsidies avoided, has actually saved money, if at the cost of some "social peace."

The Ozone Shield

For billions of years, algae in the oceans produced oxygen, but most of it remained in the ocean. Oxygen is highly reactive and it found an abundance of minerals such as iron to oxidize. Consequently, the oxygen never made it into the atmosphere. As long as this situation was sustained there could be no aerobic life on earth. It was not until about two billion years ago that oxygen had exhausted the supply of minerals in the ocean and began to accumulate in the atmosphere. But even then, any aerobic organism still would have succumbed to the ultraviolet radiation which at that time was unfiltered by ozone. UV radiation breaks down many molecules including DNA.

Once in the atmosphere, the oxygen molecule (O_2) is split by UV radiation into O, a highly unstable atom, which then either combines with another O to form O_2 or combines with O_2 to form ozone, O_3. It was not until the last billion that there was sufficient oxygen and ozone to promote the rapid evolution of life forms during that period [Schneider, Laboratory Earth, p. 26].

In 1928 DuPont Co. introduced Freon to replace ammonia in the cooling systems of refrigerators. At the time, it was considered a great technical advance. Freon is a chloroflouocarbon (CFC) that was used later in aerosol sprays and to make styrofoam materials for insulation and for packaging materials. In 1973 a post-doctoral student, named Molina, discovered that while CFCs were inert in the troposphere they were broken down in the stratosphere by ultraviolet radiation. The CFCs then become catalysts setting-off an ozone destroying chain reaction. The results were published in 1974, and the article advocated shutting down the 8 Billion dollar CFC industry. Du Pont refused to curtail production alleging that the calculations were "speculative." [Ehrlich & Ehrlich p. 115].

Humans are protected from harmful UV-B radiation by the Ozone layer that encircles the atmosphere. If Molina is right then the depleted ozone shield would allow more harmful UV-B radiation to strike the earth, plants, animals and humans. As UV-B radiation can destroy DNA, it has many adverse effects on plants and animals. In particular, when exposed to higher levels of Ultra-violet radiation, humans suffer a higher incidence of skin cancer, cataracts and from suppression of the immune system response. The latter effect, of course would produce the same effects as the AIDS virus [Ehrlich & Ehrlich p. 118].

Ozone layer depletion is allegedly caused by CFCs diffused into the atmosphere. The CFCs are used in refrigeration, propellant gas, and styrofoam. CFCs have been very useful in that they have greatly reduced the cost of refrigeration. Nevertheless, the production and use of

CFCs has been restricted. In 1987[56] 23 nations signed the Montreal Protocol which mandated a reduction of CFC use to 50% of the then-current levels by 1999 [Ehrlich & Ehrlich p. 122]. The Protocol makes specific exceptions for the developing countries who have benefitted greatly, in terms of reduced food spoilage, from Freon. Since CFC use in the poorer nations is one-tenth that of the industrial nations the environmental impact will be minor. Critics of the ban, such as arch-conservative Ronald Bailey, claim the higher cost of substitutes will delay the arrival of refrigeration to the third world and "many people will continue to go hungry" [p. 138].

In London in 1990, 93 nations agreed to terminate production of CFCs by the end of the century. China and India, after a caustic denunciation of the U.S. for pressuring poor nations into the ban, agreed, only reluctantly, when the U.S. agreed to pay $240 million to help poor nations find cost-effective substitutes for CFCs [Ehrlich & Ehrlich p. 125].

It is believed that the chlorine in CFCs depletes the Ozone layer in the upper atmosphere. This is a health problem because the Ozone layer protects humans from carcinogenic ultraviolet radiation. Some believe the current epidemic of skin cancer is, at least partly, the result of the depletion of the ozone by CFCs. One "rough" estimate reported by Ehrlich & Ehrlich is that for every one percent loss of ozone, non-melanoma skin cancers will increase by 3% [Ehrlich & Ehrlich p. 118]. As for fatal melanoma, the ozone risk seems minimal. Melanomas are more likely the result of infrequent vacation sunburns or deep tans. Others claim the non-melanoma cancer epidemic is the result, not of ozone depletion, but of more people being exposed to the sun, say because of population shifts to the south and southwest and more time being spent outdoors than in the past.

Ozone is produced when ultraviolet radiation splits oxygen molecules (O_2). The free molecules bond with O_2 to produce O_3 . Ozone, in the lower atmosphere is a toxic form of oxygen. However, in the stratosphere Ozone filters ultraviolet radiation, thereby protecting plants, animals and humans. The ozone layer varies in size in natural cycles related to solar variability (sun spots). According to critics of environmentalist claims, there has yet to be established that there has been any permanent trend toward deterioration. Indeed, according to Ronald Bailey, the ozone layer increased 5% during the 1960s so the recent decline may simply be a return to normal levels [Bailey 136-138]. Bailey failed to include a chapter devoted to Ozone depletion in his most recent (1995), "the real truth about the environment" volume. Perhaps, he has accepted the "consensus of the scientific community" [Ehrlich & Ehrlich p.117] that ozone depletion is a real problem - I think not. On page two, in the only reference to ozone depletion in the 472 page volume, he notes that atmospheric models used to predict the effects of CFCs on ozone "failed to predict the development of the Antarctic "ozone hole" that was discovered in 1985 [Bailey 1995 p. 2].[57]

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[56] The fact that it took 14 years to reach such an agreement is to a great extent attributable to obstruction and foot-dragging of, the anti-environment, Reagan Administration during which the EPA "went to sleep" [Ehrlich & Ehrlich p. 116]. George Bush was little better.

[57] In scientific methodology failure to predict does not make a model wrong, only imperfect. Random factors might explain the anomalous observation. If a model makes a prediction that is contradicted then it is said to be falsified.

CFCs are alleged to reduce ozone through a process where solar radiation breaks down the CFC and releases Chlorine atoms. The chlorine combines with O_3 and reduces it to O_2 (ordinary oxygen) and ChO (chlorine monoxide). A complex chain reaction ensues as the new O_2 is split by solar radiation. A free O reacts with ChO to form Ch + O_2. Ch reacts with O_3 and the process begins again [Bloch & Lyons p. 83-84].

It should be understood that this process is theoretically possible, but it has not been established that it has actually happened. Indeed, some have wondered how, since CFCs are about 3 times heavier than air, CFCs could get to the stratosphere. Supporters of the CFC theory claim air turbulence carries the CFCs into the stratosphere [Gradel & Crutzen p. 157]. But, given the potential costs to humans, flora and fauna, manufacture and use of CFCs were banned as of 1995 by the EPA [Bloch & Lyons p. 92].

By the way, as they absorb infrared radiation and reflect it back toward earth, CFCs also have greenhouse effects which, when measured, appear to be equivalent to those of methane [Gribbin p. 146].

Acid Rain

Another form of air pollution that comes from burning fossil fuels is sulphur dioxide (SO_2)[58] and Nitrogen dioxide (NO_2). NO_2 reacts with sunlight to form tropospheric ozone, a form of oxygen that is toxic to all living things. On dry days the SO_2 drifts on the wind and settles as dry deposition onto the leaves and needles of trees. On rainy days, the SO_2 mixes with rainwater to form a precursor to sulfuric acid which can erode buildings, kill aquatic life, damage wildlife habitat and kill trees. Acid rain is believed by many to exacerbate global warming by contributing to the defoliation of forests. The "acid kills by causing cell walls to collapse, by damaging the stomatal wax plugs that enable conifer needles to exchange gasses with the atmosphere while conserving water, and by leaching nutrients from needles and leaves" [Muir, Reflections, p. 241]. The acid deposed as rain "kills the denizens of the topsoil" thereby undermining soil fertility [ibid. p.241]. Acid rain also alters the pH of lakes and ponds so that fish and even algae cannot survive in them. "Many abandoned granite quarries are so free of algae one can see one hundred feet down to the rocky bottom" [ibid p. 241]. As Diana Muir has commented, "nature is supposed to be murky"[ibid. p. 241]. When combined with the effects of ozone acid rain is "devastating." "Weakened by nutrient leaching, stunted by nutrient depleted soil, with leaves impaired in their ability to photosynthesize, the trees succumb. The immediate cause of death may be natural, even mundane: drought, cold, pear thrips, woolly aphids. Healthy trees withstand the onslaught; forest weakened by acid and ozone die" [Muir, p. 242].

Acid rain was first noticed in the 1970s in Sweden and Norway when it was discovered that many lakes had become too acidic to support fish. Mountain lakes in Colorado revealed

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[58]About 70% of anthropogenic sulfur emissions are the result of coal-burning. About 21% come from smelting and oil refining. There are biogenic sources of sulphur, e.g. the reduction of sulfates in anaerobic environments by bacteria. Some sulphur is also released by volcanoes . Anthropogenic sources account for about 30% of atmospheric sulphur and biogenic sources produce about 49%. Volcanic activity produces on 1-3%. Sea salt formations also add about 20% [Meszaros p. 72, 73, 74]

similar problems. Then came reports of damaged forests and lakes from New England, Ontario and the Adirondack region. In the mid-1980s German studies revealed *Waldersterben* (the death of the forests) in Bavaria and the Black Forest. The majority of trees in Germany were damaged and some imagined a Germany without trees. Although they recognized some localized damage both France and the UK reported negligible damage to trees from acid rain [Dryzek p. 3].

In 1991 18.5% of Europe's broadleaf trees and 24.5% of its conifers were moderately (25-60% leaf loss) or severely (over 60%) defoliated. In the UK, Poland and Czechoslovakia the percentages averaged 57%, 45% and 41% respectively [World Resources p.199]. But a Finnish Study of the period 1971-1990 not only found no decline in European forests, but recorded an increase of between 25 and 30% [Bloch & Lyons p. 98-99]. This observation is the salutary result of changes in land use that allowed land cleared for agricultural purposes to revert to forest. It does not obviate the fact that forests are being damaged, that is, degraded, by acid rain. Indeed, studies of Africa have found that the major reason for the loss of carbon storage capacity was actually forest "degradation" brought about by timbering and land-clearing for agriculture. While technically still a forest, degraded forest areas are less effective in providing ecological services such as carbon storage, water filtering, flood and erosion control. This is not to mention that such degraded forests are less aesthetically pleasing and provide less recreational services and tourist revenue.

In the US, the EPA claimed that acid rain not only defoliated forests, but also greatly increased the acidity of lakes, killing fish and other wildlife. However, a ten year, $500 million study, found no evidence of widespread forest deterioration or increases in water acidity in the Adirondack region.[Bailey 160] In the United States the only forest area known to suffer from acid rain is in the Los Angeles Basin and the southern Sierra Nevada. The fogs in the LA area have a pH[59] of 3, but one was recorded at 1.7 [Dradel and Cruzen p. 51]. By comparison, the worst acid rain elsewhere has a pH of 4.1 and lemon juice has a pH of about 2 [Bloch & Lyons p. 96]

A study, published in Science in the early 1980s, provided impressive evidence that the high acidity found in many lakes was the *natural* result of run-off of water over acidic soils and thus was not caused by industrial activity [Bloch & Lyons p. 100].

The largest estimate of damage from acid rain was 5 billion in 1978 for the eastern 1/3 of the country. Others put the damage at about 100 million. The 1970 Clean Air Act mandated a reduction of 8 million tons per year in SO_2 emissions. The 1990 act reduce the amount by another 10 million tons. One estimate puts the cost of such reduction at abut $100 billion over the next 20 years [Bloch & Lyons p. 103]

There is a costly but effective way of reducing acid rain called "smokestack scrubbing." As the SO_2 laden smoke goes up the stack it is scrubbed by a wash of lime and water which

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[59] pH is measured on a logarithmic scale from 0 to 14. Pure water has pH of 7. 0 is high acid, 14 is high base. Because air contains CO2 rain and CO2 form carbolic acid so even pre-industrial rainfall had a pH of 5-5.6 [Bloch and Lyons p. 95]. The combination of carbonic and sulphuric acid reduces rainfall pH to about 4.0. Battery acid has a pH of 1.0, tomato juice about 4.4, and the average New Jersey rainfall about 4.2 [Gradel & Cruzen p.51]

removes 95% of the SO_2[60]. The sludge is then treated to remove the valuable sulfur from it. Smokestack scrubbing was mandated for all new coal-burning power plants by the 1970 Clean Air Act and also in the Netherlands and West Germany. In the U.S. the "cheaper" solution of forcing the utilities to use the abundant supplies of low sulfur coal from the western U.S. was defeated by a coalition of eastern mining interests (including the unions) and environmentalists. The companies and the unions that mine high sulphur coal opposed the cheap alternative for obvious reasons. Environmentalists, not being interested in cheap solutions that do not eliminate all pollution also pushed for scrubbing. The result was a law that imposed scrubbers only on new plants and imposed no requirements on coal use.

Early in the 1990s, the EPA, with the support of environmentalists, adopted "market-based" programs, i.e. the creation of allowances to pollute with a market for the allowances to be bought and sold. With an allowance the firm is allowed to emit one ton of SO_2. Firms compare the cost of reducing emissions with the cost of purchasing a permit. Those which can reduce emissions at a cost under $380 per ton (the current price of a permit) will do so, others will buy the permit. This system produces a cost-effective reduction in emissions. Over time the number of permits issued by the EPA will decline and the acid rain problem will be reduced.

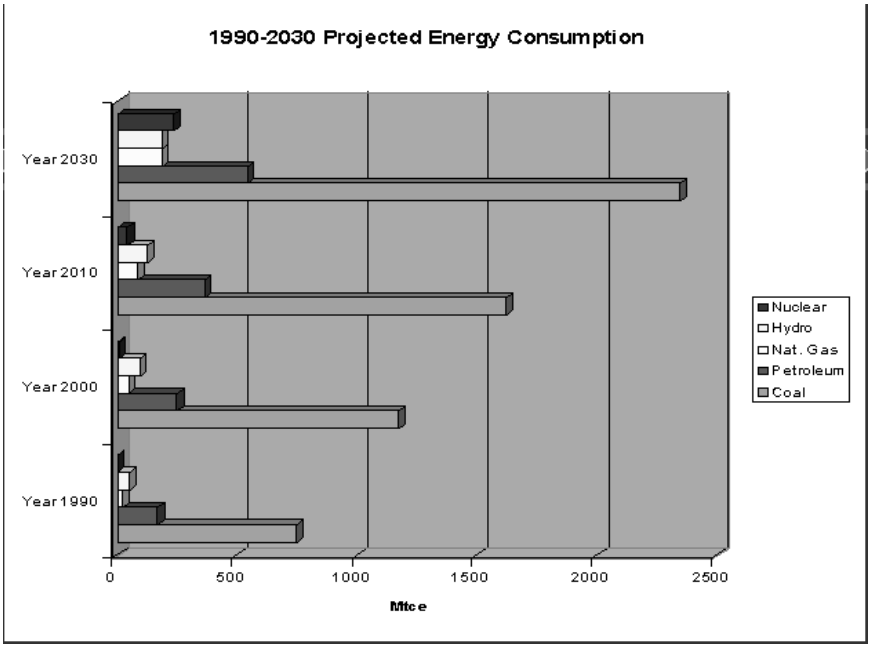
Concern about acid rain depends on whether one is an importer (Norway, Sweden, Colorado, New England) or an exporter. Places such as Arizona and Ontario (home of a coal burning copper and nickel smelters) and France and the UK are all exporters of acid rain (spatial displacement, medium displacement) tend to deny the existence of the problem [Dryzek p. 6].

[60] When coal is burned, "100% of the carbon content is converted into carbon dioxide and water. Mineral impurities are converted into gaseous sulphur and nitrogen oxides, and particulate ash (a mixture of carbon, silica, alumina, iron oxide, organic compounds, and trace quantities of heavy metals. About 95% of fuel sulphur is converted to sulphur dioxide, of which 1-5% is further oxidized in flue gasses to form sulphur trioxide. When combined with water vapor in the atmosphere sulphur trioxide forms sulphuric acid" [Therese Feng(1999),*Controlling Air Pollution in China*, p. 13

Acid rain is not a problem that is limited to Europe and the United States. However, while most developed countries are taking steps to reduces SO_2 emissions, the developing nations will continue to expand emissions. China, which produces 80% of its electricity with coal and is committed to coal for most of its expanding capacity [Feng, *Air Pollution in China*, p. 1]

China produces as much SO_2 as the four largest western European nations and in some regions is showing rainfall pH similar to those in other industrialized nations. Rising rainfall acidity is being recorded in South Africa, Australia, Malaysia, Thailand, and Southern Brazil where the Sao Paulo area has recorded rainfall with a pH of 2.7 [Bellini p. 110], Nations such as Turkey, Ireland, Greece and Bulgaria are expected to more than double their emissions by the year 2000 largely because of the burning of coal for energy [Bellini p. 111].

It is ironic that Japan, a model nation when it comes to air pollution will be the victim of China's expansion of coal burning. Early in the 1970s Japan embarked on a program to reduce SO_2 and NO_x emissions. The Japanese switched to low sulphur fuels and began a program to de-sulphurise fuels. Heavy SO_2 polluters were taxed with the proceeds going toward support of the medical treatment of individuals harmed by air pollution. By 1980, Japan had reduced SO_2 emissions by 75%. As China's growing emissions are blown over Japan much of the benefit of Japan's very costly program will be lost.



Source: Tsinghua University 1999, Climate Change Country Study

Water Pollution and Depletion

Water has been critical to the making of human history - Environmental historian, Donald Worster

The Frog does not drink up the pond in which it lives - Inca Proverb

In London, ... they find no better use for the excretion of 4.5 million human beings than to contaminate the Thames with it at heavy expense - Karl Marx, Capital [Vol. 3, ed. by F. Engels, 1867, p. 101]

Water is essential to species of living things. While there is a great deal of water on Earth, most of it, being either salty or frozen is not usable by humans. Of the fresh water in rivers, lakes, and aquifers that is accessible, humans currently use about 50%. Of that some 70% is used for agriculture [Vitousek, et al., Science, 277, p. 497].

Our waters are polluted by acid rain, oil, fertilizer, pesticide and herbicide runoffs, solid waste (mostly livestock and human sewerage), plastic wastes (sea birds are found strangled by six-pack rings and suffocated on plastic pellets). Fresh water, which makes up only .008% of the earth's supply of water [World Resources p. 181] is scarce, but is being wasted in prodigious amounts. For example, it takes 3000 gallons of fresh water to produce a single pound of beef. Scarcity of fresh water will certainly be a source of political instability the world over during the next century.

The availability of fresh water is one thing, its safety is an entirely other matter. Some 90% of human infections with diseases in developing countries have been attributed to polluted water [David Pimentel and John Morse, Malnutrition, Disease and the Developing World, *Science*, 300 (11 April, 2003) p. 251]. For eons the people of Bangladesh drank fresh pond water, virtually all sources of which were heavily polluted. The ponds were often also sewers, and especially after monsoon rains caused flooding, all were contaminated. Consequently, the people endured regular epidemics of dysentery, and other water-borne diseases. Indeed, Bangladesh has as much cholera as any place in the world. Children in Bangladesh suffer fearful rates of diarrhea and those who survive are often stunted in their growth and development.

Over a two decade period, the nation, with much foreign aid, developed a new water system, a system of tube wells, to eliminate the need to drink polluted pond water. There was a tubewell within 80 meters of every family [Tabibul Islam, Environment- Bangladesh: Arsenic Poisoning Becomes a National Problem, World News: InterPress Service, Nov. 17, 2001]. Unfortunately, the water delivered by the tube wells is contaminated with arsenic, thereby exposing about one-half of the nations 120 million people to toxic levels of arsenic. The first case of arsenic poisoning was diagnosed in 1990, and it was soon linked to the tube wells. An official of the World Health Organization has asserted that Bangladesh is experiencing “the largest mass poisoning of a population in history” [Barry Bearak, Bangladeshis Sipping Arsenic as Plan for Safe Water Stalls, *New York Times*, 7/14/02]. It appears that the well-water was never tested for arsenic contamination. When finally tested in 2000, the arsenic load in the water was, at .760 milligrams per liter, about 76 times that thought safe by WHO standards [Bearak]. The cause of the arsenic contamination is controversial. Some contend the contamination is the result of natural processes. The presence of the problem in the neighboring areas of West Bengal in India and in Inner Mongolia suggest natural forces. Others say the problem is anthropogenic. One public official implicated the over exploitation of groundwater for purposes of irrigation. Another blames rural electrification, that is, the millions of arsenic coated electric poles [Islam].

Yet others blame the extensive use of pesticides [Islam]

The Great Lakes of North America is the worlds largest fresh water ecosystem. Today less than 3% of the Lake's 5.382 miles of U.S. shoreline is suitable for swimming, for supplying drinking water, or even for supporting aquatic life [Abramowitz in Brown 1996 p.73]. The Great Lakes are polluted by agricultural runoff, human waste, and household detergents, PCBs, DDT, chlordane, mercury, dioxin and some 30,000 other chemicals. Through the process of bio-accumulation many of these chemicals concentrate in fish. For example, one ingests the same amount PCBs by eating a single two-pound trout as one would get from drinking lake-water for one thousand years [Abrahmowitz p.73].

Native fisheries have collapsed in the Great Lakes as a consequence of the pollution and the introduction of exotic species to the lake system via the opening of the St. Lawrence Seaway. The St. Lawrence Seaway connected the Great Lakes to the Atlantic Ocean and this allowed new species of animals to enter the lake systems. Two such species have been particularly destructive. The sea-lamprey, an ocean based parasite, virtually wiped out the Lake's trout population. The Zebra mussel is so prolific it monopolizes the plankton needed by native mussels and fish and is a nuisance to power plants (clogs intakes) and shipping. The costs of controlling the zebra mussel approach $5 billion per year [Abrahmowitz p. 74].

Agriculture uses more than 70% of the world supply of fresh water, but in some areas the water is so polluted it cannot be used even for agricultural purposes [David Pimentel and John Morse, Malnutrition, Disease and the Developing World, *Science*, 300 (11 April, 2003) p. 251]. "Water in indispensable to food production, and has no substitutes" [Gardner p. 86] Yet, regional water shortages are now prevalent. Some 26 countries, home to 230 million people are now encountering water shortages that limit food production [Gardner p. 86]. This problem will only worsen as nations like China, India, Iran, Pakistan and the United States deplete underground aquifers, by pumping out water faster than it is restored by rainfall [Gardner p. 86].

In 2002 a UN report on environmental trends warned of “severe water shortages in the Middle East by 2032" particularly in Arabia, Syria and Iraq where 90% of the population will suffer from “severe water stress” [Andrew Revkin, New York Times, 5/23/02].

In 1995 the average per capita consumption of grain was about 300 kilograms (direct plus indirect consumption through the eating of animals). With the annual growth of the world population expected to be about 90 million, some 27 billion cubic meters of water will be necessary to grow the grain needed to feed the expanded population[61] [62]. It might be possible to

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[61]. In some parts of the world urban and industrial use of land does not infringe on agriculture e.g. South America and Africa, but this is no so in Asia. Growing urban populations are encroaching on agricultural lands. In Indonesia each year 10,000 hectares of agricultural land are needed just for new housing. Industrial and infrastructural needs also eat up crop land. In the past decade China has diverted enough land to industry and infrastructure to feed 10 million Chinese [Gardner in Brown 1996 pp.80-81].

[62]16. Grains provide over 1/2 of the daily caloric intake of humanity [Gardner in Brown 1996 p. 80] It take about 1000 tons of water to produce a ton of harvested grain [Postel p. 41].

capture more rainwater by expanding the land under cultivation, but this appears unlikely. Since the amount of grain land peaked in 1981 and is some 10% lower in 1996 [Gardner in Brown 1996 p. 80], virtually all of this grain will have to be grown on irrigated land. In the face of already falling water tables, depleted river flows, and growing urban demands for water, it is difficult to see where this water will be found. Several major rivers including the Ganges and the Colorado are so drained by dams and diversions that they no longer reach the ocean [Postel p. 29]. By 2025 the world would have needed to add water supply equivalent to nine times the annual flow of the Nile River [Postel p. 41].

The water situation in the American West is critical. The west is defined by its aridity. In order to farm land at least 20 inches of rainfall per year is needed which is far more than falls in the agricultural areas of the west. Without irrigation water supplied by river diversion and the pumping of water out of underground aquifers, agriculture in the west is simply impossible. In California, for example, 85% of all water used is for irrigation. Some 60% of the irrigation water comes from a system of dams and canals that diverts river flows into California fields. The remaining 40% comes from nonrenewable aquifers which even as early as the 1930s had been seriously depleted. The Ogallala aquifer which supplies water to the irrigated agriculture in the so-called "dust bowl" states of Texas, Nebraska, New Mexico, Oklahoma and Colorado, is the "largest and fastest disappearing aquifer in the world" [Reisner p. 10]. Since the 1940s the "fossil water" from the Ogallala aquifer have transformed the "dust bowl" into 11 million acres of corn, cotton and alfalfa. Water was being extracted from the aquifer at such a prodigious rates that, in 1970 experts predicted it would be fully depleted within 40 years. Since then water conservation practices have reduced the extraction of water by nearly half, yet it is certain that at some point the aquifer will be fully depleted. The issue is whether it is wise to squander this fossil water on crops that can be easily be grown elsewhere on "rain watered land" [Nadavukaren p. 557]. Saudi Arabia provides a very good example of how fossil water is being squandered.

In order to reduce its dependence on food imports, Saudi Arabia subsidizes farmers who grow wheat in the desert. By 1990 Saudi Arabia had 7.5 million acres of land growing 4 million metric tons wheat. Since domestic demand consumes only one million metric tons, the Saudis must export or give away the remaining 3 million metric tons. It costs the Saudis more than 8 times the world price to grow its own wheat. Subsidies to farmers amount to $500 a metric ton [Nadavukaren p. 558]. Of course, such crops cannot be grown without irrigation water, 90% of which is drawn from nonrenewable fossil water. It is not known how long the fossil water will last, but surely some day it will be gone. A similar mania has struck Muammar Quddafi who intends to produce a :great man-made river in the desert of Libya. The project involves piping underground water across the Sahara desert to the Mediterranean coast of Libya where it will be used to irrigate cereal crops and pasture lands. It is estimate that the great man-made river will run dry in about 60 years [Nadavukaren p. 558].

The depletion of underground aquifers is a global problem with many dimensions, economic and political. In inland areas, the depletion of aquifers is followed by the drying up of the springs and streams that they fed. In coastal areas the reduced volume of fresh water invites the seepage of salt water into the aquifer. Salt water intrusion threaten aquifers and water supplies to coastal areas around the world. Major threats exist for areas such as Southern California, South Florida, New Jersey, Long Island, Israel, Senegal, Peru and Indonesia to

mention just a few [Nadavukaren p. 555].

In many countries cities are literally sinking because the groundwater under them is being pumped out causing water tables to fall. For example, Shanghai, China's largest city and one of the most densely populated cities in the world, sank about 8 feet between 1921 and 1965. In order, to stop the sinking, the city was forced to reduce pumping rates and to replenish groundwater by injecting "used water" back into the ground. Thus, while the rate of sinking has declined to about 2mm per year, Shanghai has paid a heavy price in terms of the pollution of its already "smelly and distasteful" ground water [V. Smil, The Bad Earth, p. 163-164]. It is fortunate for Shanghai that it is not heavily reliant on groundwater for drinking water. Unfortunately, over 40 major cities in China must extract their drinking water from heavily polluted groundwater stocks. The pollutants, the products of industry and agriculture, include "phenols, cyanic compounds, arsenic, mercury, chromium and nitrates [Smil, 1984, p. 95]. Indeed, in some places the ground water, laced as it is with heavy metals such as chromium and cadmium, is unfit for irrigation [Smil, 1984,p. 95].

We usually associate political tensions in the middle east with religion and oil, but now water is a major bone of contention. Countries like Israel, Egypt, Syria, Jordan and the Sudan are in constant conflict over scarce water. The threat of diversion of some of the flow of the Jordan River into Israel contributed to the start of the 1967 Arab-Israeli War [World Resources p. 182]. Water remains a bone of contention to this day. It was only in 1995 that Israel recognized that the Palestinians had any water rights at all. Palestinian access to water has been restricted virtually to water piped in by Israel at exorbitant prices [Postel p. 35]. During the hot summer of 1998, in the Palestinian city of Hebron water became so scarce the people could expect running water only once every fifteen days. While Israelis used water to water their lawns and wash their cars, the Palestinians used water only for drinking: washing clothes and showers were out of the question. The Israelis have virtually prohibited the Palestinians from sinking new wells, insisting instead that the Palestinians use very expensive desalinization plants to supply water. As long as water remains scarce there will be no peace in the middle east [NYT 8/15/98].

Similar tensions exist between Iraq and Turkey over the waters of the Tigris and Euphrates. Pakistan and India fought for control over the Indus. India and Bangladesh contest the flow of the Ganges[63]. Experts agree that should Ethiopia proceed with its plans to expand the use of Nile waters for irrigation it will almost certainly mean war with Egypt [Sandra Postel in Brown 1996 p. 49] As the United States gives Mexico some economic aid in the form of dollars, it simultaneously deprives Mexico of the waters of the Colorado River creating severe economic problems in Northern Mexico's food and cattle industry [Postel p. 40].

The increasing diversion of water to irrigation produces other ecological and economic problems. The Aral Sea in Kahzakstan was once the world's fourth largest lake. However, due to river diversions to provide irrigation water to grow cotton in the deserts of Central Asia, the Aral

[63]In the early 1970s India diverted the water of the Ganges toward Calcutta with the Farakka Barrage. Consequently, Bangladesh has suffered from serious water shortages during the dry season. The government of Bangladesh claims 40 million people are suffering poverty as a consequence of India's actions [Postel p. 41].

has lost 1/2 of its surface area and 2/3 of its volume. The edge of the sea is now 44 miles from its original shore [Feshbach and Friendly p. 74] The lower level of river flows has raised the concentration of salt and toxic substances making the water dangerous to drink. The number of fish species has dropped from 24 to 4 and the fish catch, which supported 60,000 jobs, has dropped to zero. The deltas of the diverted rivers have deteriorated. Wetlands and forests that were the habitats of dozens of animal and waterfowl species have disappeared [Postel p. 47]. The sea was a moderating force in the microclimate of the region; it warmed the winters and cooled the summers. As the sea lost its volumes the summers became hotter, the winters colder, and storms more severe. The early frosts and hot summers damaged the cotton crop. To exacerbate things the cotton crops were wantonly doused with herbicides, pesticide, and fertilizers which washed back into the feeder rivers killing fish and poisoning water supplies. Moreover, the storms blew up 140 millions tons of salt and sand from the exposed sea bottom and spread it over the entire region and its people, fouling the drinking water and undermining the health of the people of the region [Feshbach and Friendly p. 73-75]. Tulepbergen Kaipbergenov testified before the Soviet Congress of People's Deputies in 1989 that "two out of three people examined in public health dispensaries are ill - mainly with typhoid, cancer of the esophagus and hepatitis...Worst of all most of the sick are children." He goes on to exclaim that "doctors recommend against breast feeding because mother's milk is toxic." Over just a few years the infant mortality rate climbed to double the average Soviet rate and maternal death rates tripled [quoted in Feshbach and Friendly p. 73, ibid p. 75].

The irrigated cotton lands soon became waterlogged and quite saline and cotton yields began to fall. To compensate for the falling output Central Asian peasants were ordered to convert their private plots, which they used grow, fresh fruits and vegetables and a little milk and meat to cotton production, thereby lowering dramatically the quality of the Uzbek diet [Feshbach and Friendly p. 77]. The Aral Sea disaster was the most" horrific...symbol of a sixty year pattern of ecocide by deliberate design" in the Soviet Union. The project boosted the Soviet Union to the position of number two exporter of cotton in the world, it made "many people rich and powerful," but it was enormously wasteful of water, and it exacted an enormous toll on the health and welfare of the mostly Muslim people of Central Asia leaving no doubt as to their second class status in the Soviet Union and played no small role in powering the "nationalist" movements in this region [Feshbach and Friendly p. 75].

Water crises fan both ethnic and class antagonisms. In Mauritania, water provided by a new irrigation project encouraged elite, white Moors to drive black Africans from their traditional lands. Some 70,000 people were forced to migrate to Senegal [Postel 1996 p.36-37]

In India, village wells are drying up as groundwater is diverted to cities and to commercial agriculture. This "privitization of the rural commons" is exploitive and socially destructive and is creating great hardship on the peasants. Consequently, as herds die and land the land turns to dust, families and the village communities are disintegrating [Postel p.37]

Soils

Capitalist production, by collecting the population in great centres ... disturbs the circulation of matter between man and the soil, i.e. prevents the return tot he soil of its elements consumed by man in the form of food and clothing; it therefore violates the condition necessary to lasting

fertility of the soil. By this action it destroys at the same time the health of the town. [by].. laying waste and consuming by disease labour power itself .. [Thus] all progress in capitalistic agriculture is a progress in the art, not only of robbing the laborer, but of robbing the soil. Capitalist production, therefore, develops technology, and the combining together of various processes into a social whole, only by sapping the original sources of all wealth - the soil and the labourer. Karl Marx, *Capital* (Volume 1, ed. by F. Engels, 1867, p. 505-507)

The use of land to yield goods and services represents the most substantial human alteration of the Earth System -[Peter Vitousek *et al*, *Science*, 277(1997), p.494].

Soil is the fundament of human existence. Unfortunately it is also "one of the most vulnerable of natural resources" and one upon which "humans have had many major and often irreversible impacts" [Charles Redman, 1999, p. 82]. Soil should no be confused with "land." One can have land, but not have soil, as any one who has visited an arroyo-riven desert or a gully-marked denuded hillside knows. Human civilizations have risen on quality soil and fallen when the soils were depleted.

"Soil" is a "self-regulating biological factory that acts to absorb and store water, governs water runoff, acts as a cleansing medium to purify water, as serves as the host for organisms that decompose organic material"[Redman, p. 83]. Much of the biological activity is in the top two layers know as the O- horizon (topsoil) and the A-horizon immediately below it. The two top layers can be 20 t0 40 centimeters thick [Redman, p. 83]. Unfortunately, these layers are vulnerable to several hazards - compaction and wind and water erosion [Redman, p. 83].

Plants take carbon dioxide from both the atmosphere and from the soil. If the soil is compacted, say by the weight of large numbers of livestock, insufficient air circulation results and plant growth is reduced. Clearly, one of the most beneficial ecological services of earthworms is to provide channels for air circulation thorough the soil.

If soils are left exposed to wind and water they will be washed away and the productivity of the land will be reduced. Soils so removed become sediments and may enrich the land where they are deposited either by the wind or the rivers that carry them away.

Soil erosion has been both a friend and an enemy of humankind. It was the erosion of mountain soils that led to the formation of the great, fertile river valleys and deltas that sustained the first "civilized" human societies and continue to feed billions of people around the world. Without the annual deposition of fertile sediment carried by the Nile, Tigris and Euphrates Rivers the great civilizations of Egypt and Mesopotamia could not have existed.

In the present, however, soil erosion poses a serious threat to the sustainability of current levels of agricultural production. In the United States alone, it is estimated that some 4 billion tons of soil are lost from about 160 million ha[64] of cropland each year [Pimentel et al, *Science*, 267 (Feb.1995)]. The cost of replacing, with artificial fertilizers, the soil nutrients lost in this process is estimated to be about $20 billion per year [*ibid*]. Worldwide, over the past 40 years,

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[64]In 1977, the United States had 168 million ha of cropland and some 51 million ha of "potential cropland." It was estimated that the US was losing about .1% of its cropland to erosion each year. This estimate is roughly consistent with 160 m/ha in 1995 [Gigi Beradi, ed. *World Food, Population and Development*, 1985, p. 155].

nearly a third of the arable land has been lost to erosion of topsoil, and at present is losing about another 10 billion ha each year [*ibid*]. As the world adds 250,000 people every day, the decay in the supply, and in the productivity of arable lands, that is land with fertile topsoil, poses a threat to global food security. Humankind is still in the same battle with population growth that plagued "old Europe" and stimulated Malthus to write his (in)famous essay in 1798.

David Ricardo, one of the founding fathers of modern economics, defined the concept of economic rent to be, "that portion of the produce of the earth, which is paid to the landlord for the use of the original and indestructible powers of the soil" [quoted in John Bellamy Foster and Fred Magdoff, Liebig, Marx and the Depletion of Soil, *Monthly Review*, 50(3), 1998, p. 36]. While Ricardo recognized that lands varied in fertility, he saw such variations as "natural" [ibid. P. 36]. This was so even though, as early as 1777, as manifesting the writings of Scottish agronomist, James Anderson, it was understood that humans could either enhance natural fertility or destroy it [ibid. p. 36]. Anderson, in 1801, in the context of an attack on Malthus, lamented the "gargantuan waste" of "natural sources of fertility" as manifest in London's dumping its human waste into the Thames [ibid. p. 37]. Contrary to Malthus, Anderson insisted mass starvation was not inevitable as population grew. Only better stewardship of the soils was necessary to feed a growing population.

Unfortunately, by 1830, because farmers had chosen, rather than stewardship, to destroy the fertility of the soils of England, Europe and America, all were confronted with a fertility crisis. This crisis ushered in a period of history that has come to be known as "Guano Imperialism" [Foster & Magdoff, p. 32]. Both England and the Untied scrambled for control of the guano islands off the coast o f Peru. Guano was especially prized because it was rich in both phosphates and nitrogen [ibid. p. 34]. Indeed, due to its very high nitrogen content, it was much more powerful than barn manure [Brian Fagan, *Floods, Famines, and Emperors*, 1999, p. 26].

Over the years 1848-1875, the Peruvian islands were mined, by thousands of indentured servants, convicts and Chinese "coolies,"enveloped in a most formidable, and probably toxic, ammonia stench, most of whom died in the process from "lung-clogging dust" and overwork, their dead bodies then left for packs of dogs to consume. These grisly facts are surely grist for the mill of those who might ponder the mixed blessings of human "progress." Nevertheless, some twenty million tons guano, worth about $200 million (1999 dollars) were shipped to Europe and North America [Brian Fagan, *Floods, Famines, and Emperors*, 1999, p. 23, 26]. The rich islands that had sustained the Moche and Inca cultures for thousands of years were virtually stripped bare in 30 years.

Of course, the crisis in agriculture was forestalled with the invention of manufactured fertilizers in the 1860s and the explosion in the manufacture of cheap nitrogen fertilizers after WWII. During the war, the United States developed a huge munitions manufacturing capacity. As the processes of manufacturing for munitions required nitrogen fertilizer,[65] the production of nitrogen fertilizers for civilian use grew dramatically after the war. Just as dramatic was the decline in the use of crop-rotation using nitrogen-fixing fodder crops of legumes such as clover

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[65]Ammonium nitrate "fertilizer" is a key ingredient in bombs. In 1947, a shipload of this fertilizer exploded in Texas City, Texas killing hundreds and injuring thousands more. On an even sadder note, ammonium nitrate was the explosive used in the bombing of the Federal Building in Oklahoma City in 199x.

and alfalfa hay and the virtual disappearance of ruminants and pigs from crop-producing farms [Foster & Magdoff, p.40]. These animals are now raised on feedlots and "factory farms" that cause a host of environmental problems of their own which we will visit in due time.

The availability of cheap fertilizer and, those other "gifts" of WWII, pesticides, herbicides and fungicides laid the foundation for the explosion in agricultural productivity that made the United States the "breadbasket of the world." But, just like guano, these new substances have been a "mixed- blessing.[66]"

- Fertilizer production is energy intensive uses great amounts of non-renewable energy. Fertilizer production uses 40% of the total energy used to grow and ship an acre of corn.
- Being water soluble, fertilizers cause contamination of ground and surface waters with carcinogenic nitrates.
- Lack of crop rotations and the use of pesticides has reduced the amount of organic material in, and the biodiversity of soils. The latter tends to lower the natural defenses of plants to pests and diseases, thereby requiring the use of even more pesticides.
- The massing of animals in feedlots and "factory farms" raises human cruelty to animals to new levels, and requires the intensive use of antibiotics to prevent infections. The latter introduces anti-biotics into human food and encourages the development resistant strains of bacteria.
- Mining, transportation and burning of coal and oil produce a number of environmental problems.

The deleterious effects of inorganic fertilizer production and use, and the associated use of pesticides has led to a resurgence of advocacy of organic farming - the use of organic fertilizers (human and animal manures and green manures[67]) to sustain fertility and integrated pest management to control pests. Not only does organic farming protect the fertility of soils, it also reduces the need for energy and promotes biodiversity. The latter effect is the consequence of the diversity (within and between)[68] of crops produced with organic methods and the elimination of the disastrous effects of pesticides on "friendly species" and of fertilizers and pesticides on crucial soil biota. In this regard, one should recall Darwin's assertion that, as far as human history is concerned, the most important creature on earth has been the earthworm.[69]

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[66]The list below is derived from Foster and Magdoff, pp.42-43.

[67]Green manures are crops that are planted to protect and replenish land in rotation with food crops. The plants protect the field from erosion, encourage nitrogen fixing, and can be plowed back into the soil. Some may be fed to animals to produce manure.

[68] Conventional agriculture produces a single crop (monoculture) of genetically identical individuals with no rotation to restore soil fertility.

[69]Earthworms and other soil biota are "recyclers" that sustain soil fertility. Earthworms ingest dead surface biomass and redistribute it to deeper layers of the soil by way of their excretions. They also aerate the soil. Fungi decompose biomass and mineralize the nutrients contained within them. Bacteria provide nitrogen fixation, denitrification, and nitrification. Arthropods are "processors and mineralizers of dead organic matter." [V. Smil 1993, p. 249 n. 7]. Darwin's reference to earthworms is in *The Formation of Vegetable Mould Through the Action of Worms*,

Advocates of "modern" farming contend that the world face a trade-off between its environmental and humanitarian concerns. While organic farming may provide environmental benefits, it could not possibly produce enough food to feed the poor masses of the world. For example, Indur Goklany at the US Department of the Interior, contends that that a switch to organic methods of farming would reduce food production by at least 20%. Vaclav Smil claims the reduction would be closer to 50%. Indeed, Smil claims that the "synthesis of ammonia" was the "most significant invention" of the 20th century, "roughly half of humanity survives thanks to industrial ammonia synthesis." Even should the world become vegetarian, Smil contends that without synthetic nitrogen only 2/3 of the world population could be fed [V. Smil, *China's Environmental Crisis*, 1993, p. 163]. In short, while Europeans and Americans are well-fed and are producing unsustainable food surpluses with the aid of synthetic nitrogen, could tolerate a reduction in food production, it would prove disastrous to the one billion people in developing countries who now suffer from hunger, and the additional billion who would soon join them [Indur Goklany, The Ins and Outs of Organic Farming, *Science*, 298 (6 December 2002), p. 1889].

Adequate food could be grown using organic methods if the world adds about 50% more farmland, but this critics contend, would diminish their "environmental and biodiversity advantages"[Goklany, p. 1889]. But, in countries such as China, there is no possibility of adding more land to cultivation. According to Smil, China has "virtually no reserves of new land,...and there is no land tied up in production of exportable surpluses and hence available for increased domestic food supply"[1993, p. 181]. Indeed, one thinks of China, India, and Africa one thinks about loss of land productivity due to erosion, loss of fertility, desertification, and loss to industrialization and its requisite infrastructure rather than of opening of new lands to cultivation. Indeed, given these factors, there is not a little doubt that China will be able to sustain its current level of food production [See Lester Brown, *Who Will Feed China*, 1995].

Moreover, critics of organic farming fail to note that while use of synthetic fertilizers have doubled agricultural yields over the past thirty years, "conventional farming has degraded soils irreversibly in large areas of the world, and consequently the remaining land will be farmed as well, rather than used for ecological compensation" [Paul Mäder et al, Response to Goklany, Science, 298 (6 December 2002), p. 1889]. In short, due to its destructive impact on soil fertility, the current level of production from conventional agriculture is unsustainable.

Organic farming,, on the other hand, would use 35-51% less fertilizers, 20-41% less energy, and 96% less pesticide thus avoiding the deleterious effects of the latter on soil fertility and biodiversity [Goklany, 2002, p. 1889]. While the organic system may require some 25% more land, it enhances soil fertility and is, thus, sustainable [Mäder et al, p. 1889].

"*Earth is the word we use when it is there in place, growing the food we eat, giving us a place to stand and build on. "Dust is what we say when it is lose and blowing on the wind. Nature encompasses both - the good and the bad..... We need the earth to stay alive, but dust is a nuisance, or worse, a killer.* - Donald Worster, *The Dust Bowl*, 1979, pp.12-13

A nation that destroys it soil destroys itself - Franklin Delano Roosevelt, 1937

1888, p. 316, quoted in V. Smil, 1993, p. 249, n.7]

A tale of two systems

The American "Dust Bowl" surely ranks among the greatest of human "ecological blunders" of all time [Donald Worster (1979), *The Dust Bowl: The Southern Plains in the 1930s*, p. 4]. Environmental historian, Donald Worster, points out that the "dirty thirties" "were primarily the work of man, not nature [Dust, p. 13]. The southern plains had always been semi-arid, and the dry westerly winds always blew. It was not until after farmers had stripped the southern plains of the sod that had held the loess soil in place for millions of years, that immense dust storms blew across the region lifting its topsoil by the millions of tons, and depositing it in the eastern United States and the Atlantic ocean. Along the way, the storms buried towns, killed livestock and wildlife, and many people. These storms happened "not once or twice, but over and over for the better part of the decade:[70] day after day, year after year, of sand rattling against the window, of fine powder caking one's lips, of spring time turned to despair, of poverty eating into self-confidence" [Worster, Dust Bowl, p. 13]. Of course, the United States has no monopoly on dust storms.

Although it has occurred often enough, the destruction of the "indestructible powers of the soil" is not inevitable. In 1911, in a book titled, *Farmers of Forty Centuries*, F.H. King wrote of what we would today call the "sustainable" agricultural methods used in China, Korea and Japan. For the 7000 years that agriculture has been practiced in China, for example, the methods used were "ecologically reasonable" and thus "sustainable" [Shi ming Luo and Chun ru Han, Ecological Agriculture in China, Ch. 19 in *Sustainable Agricultural Systems*, edited by Clive A. Edwards et al, 1990, p. 299]. Over the past four decades, however, the practice of Chinese agriculture, specifically, its relationship to ecology, has changed in light of new economic and social forces. In terms of the "powers of the soil," the change has not been salutary. The adoption by China, under Communism, of western industrial agricultural methods[71] (mechanization, chemicalization, irrigation) of agriculture has resulted in a situation where farmland is being destroyed on an unprecedented scale. Between 1957 and 1977, some 27 million acres of farmland were lost to erosion and desertification [Ecological Agriculture, p. 300]. In 2003, China is losing vast amounts of land to spreading deserts, and salinization of irrigated lands. In the remaining lands fertility is so poor intensive applications of chemical fertilizers are required just to sustain fertility. Further advances in fertility and yield from this source seem to be out of the question. Farmers all over the world, realizing that additional fertilizer inputs have a very low marginal product, have reduced nitrogen inputs in the 1990s.

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[70]There were 179 storms recorded in the region April of 1933. A single storm in 1934, moving at 100 miles per hour, carried 350 million tons of "dust." It dropped 12 million tons on Chicago. The next day millions of tons were deposited in New York, Boston ,Savannah and Washington. In 1935, Amarillo, Texas recorded 908 hours where visibility was less than one mile due to "dust" [Worster, Dust Bowl, p. 13].

[71]Actually, it was China's "elder brother," the Soviet Union, that pursued the methods of the west with alacrity. The "New China" used the Soviet Union as a source of capital and as a model for its development plan [Judith Shapiro, *Mao's War Against Nature*, p.26]

In China, since the 1960s, and particularly since the reforms of 1978, yields of rice, corn and wheat have tripled due primarily to the extensive use of synthetic nitrogen fertilizer. However, the evidence shows clearly that law of diminishing returns has set in, that is, the marginal productivity of fertilizer inputs is falling. In some regions it is one-third of its level in the 1960s and in others it is about zero [Smil, 1993, p. 178]. In 1952, the ratio of grain yields to chemical fertilizer input (in kg) was 440. By 1970, the ratio had fallen to 12.8 and in 1985 it stood at 4.7 [Shi Ming Luo and Chu Ru Han, Ecological Agriculture in China, p. 303]. Between 1977 and 1984 grain yields in China increased by 7% per year, but over the next decade growth rates averaged only 1.6% per year [Lester Brown, *Tough Choices: Facing the Challenge of Food Scarcity*, 1996, p. 88].

China's use of fertilizer is already quite high by international standards. China applies an average of 200kg of nitrogen to every hectare of cultivated land compared to only 50kg in the United States. China's used of nitrogen is surpassed only by Korea (250kg) and South Korea (210kg) and Europe (220kg-500kg). In the last instance, heavy application of nitrogen is profitable only because of "extravagant state farming subsidies" that placate farming interests, but produce expensive surpluses of grains and meat and dairy products [Smil, 1993, p. 168]. However, in the more productive regions of China (Jiangsu, Zhejiang, Fujian, and Guangdong) fertilizer application rivals that of Europe [Smil, p. 168]. But, in China, the high rate of nitrogen use is a "matter of necessity, not a subsidized artifice or a luxury of animal food-dominated diet" [Smil, p. 168].[72]

Unfortunately, China's use of fertilizer is not as efficient as that of Europe. In order to get maximum effect nitrogen must be applied in fixed proportion to phosphorus and potassium. While China is one of the world's largest producers of nitrogen (N), its production of phosphorus (P) and potassium(K) is deficient leaving some 3/4 and 1/3 of China's land phosphorus and potassium deficient respectively [Smil, 1993, p. 172]. Should China manage to completely recycle all of its human, and animal waste, crop residues and household garbage, according to Vaclacv Smil, optimal proportions of N, P and K could be realized, actual rates of recycling barely reach half of what would be needed [Smil, 1993, p. 172]. Indeed, due to a shortage of fuel for cooking and heating, some 3/4 of China's crop residues are burned to heat space and warm water rather than for feeding animals to produce manure or being plowed back into the soil [Smil, 1993, p. 112].

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[72]Fertilizer use in China is subsidized as well. In 1989 world fertilizer use fell primarily because of the end to fertilizer subsidies in the Soviet Union. The Soviet Government provided the fertilizer at prices below the cost of production. When prices were adjusted to world levels, farmers drastically reduced demand for fertilizer [L. Brown, Tough Choices, p. 89]. In China, the subsidy is in this form. In Europe, on the other hand, farmers are subsidized by inflated food prices sustained by protectionist measures that remove competition from imports.

Plants need nitrogen to build amino acids, peptides and protein. While nitrogen is abundant in the atmosphere as gas molecules, N2, a stable diatomic molecule, it cannot be used by plants in this form. Bacteria in the soil expend a great deal of energy to "nitrify" N2 into nitrates (NO3) which can be used by plants to produce ammonium (NH4), a key building block of amino acids, peptides and proteins. Unfortunately, in wet environments where there is also an abundance of dead organic matter, there exist bacteria that "denitrify" -that is convert nitrates into the gasses N2 and nitrous oxide (N2O). Thus, when synthetic nitrogen is applied in such an environment there will be an increase in emissions of N2O, a powerful greenhouse gas - some 160 times more powerful than CO2. NO2 also interacts with atmospheric oxygen to produce nitric oxide (NO) which is known to deplete the ozone layer.

The heavy use of nitrogen in rice paddies, the ideal environment for denitirification, by China and other Asian nations, is making a substantial contribution to global warming and the depletion of the ozone layer.

Adding to the problem is the fact that synthesizing nitrogen requires a great deal of energy, much of which will be produced by burning fossil fuels. In addition to producing CO2 emissions, burning fossil fuels is a source of denitrification.

In China, over the past four millennia, dust storms have been commonplace, but of late the number of such storms has increased dramatically. While in the 1950s only five such big storms were recorded, there were 23 in the 1990s, and 20 in the in the first two yeas of the new millennium [Geoffrey Lean, Huge Dust Cloud Threatens Asia, *Independent News*, 26 Jan. 2003]. The storms happening in China are more intense and extensive that the great dust storms associated with the "dust bowl" in the United States in the years of the Great Depression. The storms blot out the sun in Beijing, bury thousands of villages in dust, destroy crops, threaten health, and close schools and airports [Lean, *Independent News*]. Worst of all these storms strip the land of millions of tons of topsoil, a commodity that is growing increasingly scarce in China, thus exacerbating China's agricultural problems. Harvests, after having risen fourfold over the past five decades, are now beginning to fall [Lean, *Independent News*]. The root of the problem, according to the Earth Institute, is the over-cultivation, especially of marginal land, overgrazing of land by 290 million sheep and goats, the over-cutting of forests, and the over-pumping of aquifers which lowers water tables and desicates the earth [Lean, *Independent News*]. In short, much of China is being turned into desert. The Gobi desert has grown by over 20,000 square miles and has moved to within 150 miles of Beijing [Lean, Independent News]. 30% of China's desert area has been formed in the last 50 years. A 1990 estimate places the loss of topsoil in China at 50 million tons per year [Shi ming Luo and Chun ru Han, Ecological Agriculture in China, Ch. 19 in *Sustainable Agricultural Systems*, edited by Clive A. Edwards et al, 1990, p. 300].

The dust storms originate in the Northwest provinces of Gansu and Shaanxi where there are simply "so many sheep and so little grass" [U.S. Embassy Report, Beijing, July 2002]. The primary reason why 80-90% of these arid grasslands are degraded is that the number of grazing livestock exceeds sustainable levels by 50-150% and by 300% in some areas [ibid]. The problem is that 65 million people are attempting to survive in this ecosystem which simply cannot support them on a sustainable basis. Short of a major population relocation, there is little that can be done about this problem. Less land intensive ways of raising livestock, e.g. feedlots

are not feasible due to the lack of fodder which, in turn is due to the lack of water to grow it, and high transport costs [ibid].

China's attempt to stop erosion by planting tress has been a failure, and has actually exacerbated the problem. As there is insufficient rainfall to sustain the trees, they are using up groundwater, and thus, further desiccating the soils [U.S. Embassy Report, Beijing, July 2002]. Where irrigation is provided for the trees it has taken scarce water from the Yellow River [ibid].

China is losing soil due to erosion, but also due to poor land use patterns. As China develops its manufacturing sector, and wages and profits rise, new demands are being placed on the land. The demand for factories, shopping centers, more and larger housing, highways and golf courses is eating up China's declining stock of arable land [Patrick Tyler, Nature and Economic Boom Devouring China's Farmland, *New York Times*, xx].

In 1995, Lester Brown of the World Watch Institute broached the question of whether China will be able to feed itself. If not then the question becomes "who will feed China." Brown, reasoning based on analogies with Japan, Korea, and Taiwan, claims that China will soon be unable to feed itself. In the latter countries, Brown observed, economic development has resulted the loss of agricultural not land needed to grow grains not just to erosion and desertification, but to alternative uses such manufacturing plants, roads and other infrastructure and housing. Moreover, Brown contends that the development process also increases the demand for grains because of a dietary shift to more meat consumption - it take four times as much grain to feed a person meat rather than grains. In 1995 alone meat consumption was up 12% [Chinese Food Security, U.S. Embassy Beijing, November, 1996, 1/3]. Also, more affluent people want more fruits and vegetables. As the latter are more profitable, farmers will shift land from grains to these crops further reducing grain production. Brown contends that China will not be able to meet the growing demand for grains with its shrinking supply of land, and most importantly, its increasingly deficient supply of water. Under pressure from growing urban and industrial needs, China will not have the water needed to sustain existing irrigation and surely not to bring additional acreage under cultivation.

In the five years following Brown's "wake-up call" in 1995, China experienced very good grain crops, even though the area under cultivation declined. In 2001 and 2002, according to China's National Bureau of Statistics, grain output continued to increase even though at least 2 million ha were taken out of production.

China's official response to Brown was to reject his thesis. In 1996, the State Council issued a white paper claiming that China will be able to feed itself, with only a minor reliance on food imports. China expects that it will reclaim 300,000 ha of land each year from "wasteland" to offset land lost to urbanization, and through other efficiencies in planting, harvesting and transportation it will add some 20 million tons of grain to annual production [Chinese Food Security 2/3].

An academic study published in 2001 does not share the optimism of the State Council. Using a methodology called "structural analysis"[73] researchers attempted to estimate the demand

[73] Structural analysis is uses input-output methodology. An input-output table is a construct that shows the material demands on inputs such as labor, energy, steel and land, and so on, to produce an given quantity of a specific output - say rice or a tractor.

for farmland in China in the year 2025 based on several "scenarios" related to population growth, urbanization, changes in diet, changes income per capita, technological progress and migration. The study concludes that "given the commonly excepted (sic) scenarios for demographic, social, and economic changes, as well as technological progress, sectoral outputs would drive the associated land requirements to exceed the available land area. In other words, China would not be able to support the increased demand for land-intensive products with its land- base without significant improvement in land productivity and/or increasing imports." The study further notes that the "biggest jump in demand for farmland is triggered by the income growth scenario," that is, "the increase in the indirect demand for feed-grain triggered by the higher consumption of animal products." [Klaus Hubacek, and Laixiang Sun. A scenario analysis of China's land use and land cover change: incorporating biophysical information into input-output modeling, *Structural Change and Economic Dynamics*, 12(2001) 367-397, p. 389].

Life in China has always been difficult. Most fundamental is the fact that much of China is elevated in altitude and mountainous. Millions of years ago as tectonic forces drove India into a crash with Asia, it formed the Himalayas and behind them the Tibetian Plateau, the world's highest, and vast mountain ranges. The rain shadow of the Himalayas produces deserts in the north and northwest. The Gobi Desert which runs west to east across the northen part of the country now extends to the outskirts of Beijing.

Both the Yangze and the Yellow Rivers originate in the Tibetian Plateau, and flow, at a very deep rate of descent though mountain valleys and gorges, until they reach the eastern lowlands and then the coast. With the exception of the Sichuan Basin, the eastern lowlands and the river valleys are the only places China can actually grow food [V. Smil, *The Bad Earth*, 1984, p. 4-5].

China also has also suffered from a highly variable climate and unpredictable weather. Over the past 2000 years, China has suffered from 33 rapid changes in climate of over 3C and several in excess of 7C. China seems to have followed the rest of the continent through the "Medieval Warming" and the "Little Ice Age" [S. Yafeng et al, Decadal climatic variations...from East China during the last 2000 years, *Science in China D -Earth Sciences 42 supp.*: 91-100]. Moreover, China suffers from the push and pull of Siberian cold fronts and south easterly monsoons. If the monsoon moves over the southeast too quickly, it will suffer drought and the northeast will flood. On the other hand, if the northeasterly movement of the monsoon is checked by southward-moving cold fronts, southeastern China floods and the northeast suffers droughts. Thus, not a year passes without a flood or a drought somewhere in the country [V. Smil, *Bad Earth*, p. 5]. Between 246BC and 1948, for example, more than 900 floods and 900 droughts were recorded in the Huai River basin [Smil, p. 6]. Every year floods or drought brought famine to some part of China. Between 108BC and 1911AD, China endured some 1828 famines [Jasper Becker, *Hungry Ghosts,* Mao's Secret Famine, p. 9].

Human activity, especially deforestation, has worsened China's usually precarious ecological situation considerably. Chinese civilization was founded on the "yellow soil plateau." The epicenter of this early civilization was at Xi' An, a city that is over 3000 years old that served as the capital city for 11 dynasties. Nearby is the tomb of Qui Shi Huang, the first ruler of a unified China who died 2000 years ago. Some 8000 life-sized clay figures of soldiers were buried with him.

Over one million years ago the wind blew dust from the northern deserts of Xinjiang and Mongolia south to form the loess plateau, an area of .5 million sq/km where the loess is anywhere form 50m to 300m deep. Much of this plateau is encircled by the Yellow River (Huang Ho) as it cuts to the north from Langzhou to Baotou and cuts back to the south to Xi'An. It extends to the east of the Yellow River as far as Beijing to the north and Zhengzhou to the south.

In its pristine form the plateau was covered with forest and grass. Over the eons, vast areas of forest and grasslands were cleared to make room for civilization with its agriculture, imperial palaces and cities, and now stand "desolate and wasted," a "classic paradigm of massive erosion" [Smil, p. 38, 40]. After 1949, matters only got worse as vast amounts of forest were destroyed to fuel "backyard iron-making" during the "Great Leap Forward." During the anarchy of the Cultural Revolution" illegal cutting of forests was rampant. And, finally, following Mao's dictate to " take grain as the key link," peasants deforested hillsides to plant rice [Smil, p. 15-16]. Forests provide a wide range of environmental services.

Like large bodies of water, forests are great moderators of climate. Forests are also vast reservoirs of water and soil. Loss of these services through deforestation increases the extremes of weather, and exacerbates siltation and, hence flooding is more severe[74] [Smil, p. 26-27]. All over China, there has been an increased frequency and severity of floods since 1949. While natural factors are surely involved most expert opinion places the greatest part of the blame on deforestation [Smil, p. 28].

The problem of soil erosion is not confined to the Loess Plateau. The conversion of grassland and "hilly forest lands" to grain production has produced elevated erosion rates from the northeastern province of Heilongjiang to Yunnan in the southwest and in the Yangzi Basin [Smil, Bad Earth, p. 54]. The Yangzi Basin accounts for about 20% of China's territory and is the most densely populated, and the most productive area of the country [Smil, p. 85]. It is estimated that the erosion rate in Yangzi Basin exceeds that of the Yellow River watershed by about 50%,[75] that is, by some 2.4 billion tons of top soil every year [Smil, p. 54]. Most of the eroded top soil becomes sediment in rivers and lakes, thus raising the level of the rivers and increasing the likelihood of flooding. The Yellow river, for example, rises about 12 cm each year [Smil, p. 85]. The sedimentation also fill the reservoirs of dams and storage reservoirs and thereby reduces their effectiveness at flood control.

Erosion of top soil also means the loss of the nutrients in that soil. In the Yangzi basin

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[74]Erosion also exacerbates flooding by silting up dams built for, among other things, flood control. The Sanmenxia dam on the Yellow River lost 60% of its water storage capacity between 1958 and 1973. In order to reduce further siltation, more water must be allowed through the dam in the summer flood season substantially reducing its flood control function. The yellow silt, or loess, for which the river is named, and which has historically been a great nuisance, increased after the construction of the dam in 1958, due to Mao's project to increase grain production by converting grass and forest lands on the "loess plateau" into grain land [smil, p. 42]. Finally, siltation raises the riverbed making floods more likely and periodic raising of levees and dikes necessary.

[75]The Yangzi is not nearly as silty as the Yellow River, but it has a much greater (20x) annual flow [Smil, Bad Earth, p.84].

alone, the loss of fertility is equivalent to the nitrogen output of "50 medium-sized (500,000 tons per year) fertilizer factories" [Smil, p. 55].

For thousands of years the China was able to feed its multitudes and preserve the fertility of its soils. This despite the fact that only about 10% of China's land is arable, 33% is grassland (about 1/3 of which is over-grazed and degenerated), 12% forest, 3% water and the rest is desert and mountains [Ecological Agriculture, p. 300]. About 1 billion people (out of 1.3 billion) live on less than 1/3 of the land area. The bulk of the population is concentrated in the eastern region (the Yangtze delta, Sichuan and the various coastal urban agglomerations - e.g. Shanghai). Compared to the world average of 3.47, China must feed 7.5 people with every hectare of arable land [Ecological Agriculture, p.300]. The root of China's problem is, of course, the growing population which produces a relentless burden on the soil, but the transition to a capitalist economy has exacerbated this problem. Under Communism, the Chinese managed to increase food production faster than population growth. First, land reform removed shackles on the productivity of labor imposed by the feudal-landlord system. Farmers now worked harder and longer, and made substantive gains due to scale economies produced by cooperation through collectives [William Hinton, The importance of land reform in China, Monthly Review, 50(3), p.155-56]. Moreover, through the forced mobilization of massive amounts of labor into hinterlands, millions of acres of land were reclaimed from forest, grassland and swamp [Shapiro, p. 140]. Much of this new land proved to be useless, and much was gained with unimaginable long-run ecological costs, at least for the time being, China stayed ahead of its population growth.

By 1990s, however, the situation became critical. In 1994, grain prices in China rose by 60%. Fearing food riots in the cities, the government was compelled to release surplus stocks and to import grain. The surge in demand from China drove up world prices in 1995 and 1996. Lester Brown has asserted that "there are few things the government in Beijing fears more than the political instability that would accompany rising food prices"[Lester Brown (1996) *Tough Choices: Facing the Challenge of Food Scarcity*, p. 31]. On the other hand, Beijing is concerned about the rural-urban migration that could reduce food production and flood the cities with unemployable people. Beijing has allowed food prices to rise to keep farmers on the land, but not so high as to produce chaos in the cities due to food shortage and unemployment [Lester Brown (1996) Who Will Feed China, p.31].

Even though Mao eventually relied on western methods (mechanization, electrification, irrigation, and chemicalization), he emphasized, for strategic purposes, local food sufficiency, local industry and slowed down urbanization all of which sustained the practice of protecting soil fertility [Foster & Magdoff, p. 44]. But, now the traditional Chinese "honey-bucket" that recycled the waste of "consumers" back into the soil is being used less as more people move to the city. In the cities, the sludge from waste treatment plants which was formerly used as fertilizer, can no longer be used as it is contaminated with toxic wastes from industrial wastewater [Lester Ross, *Environmental Policy in China*, 1988, p. 151]. Urban garbage, once exclusively biomass, is no longer recycled to agriculture because it contains to much of other forms of solid waste most notably paper wrapping from processed foods and other packaging [Ross, 1988, p. 151].

Under the "Deng" reforms which have eliminated cooperatives much of the biomass

that was once restored to he land is now being burned. First, Individual farmers, it appears have neither the time or the resources to process this biomass (straws, vines and roots) back into the soil [Hinton, p. 157]. More significantly, there is a serious energy shortage in rural areas which compels farmers to use biomass for cooking and heating rather than recycling it in the fields. Indeed, some 85% of rural household energy comes from the combustion of biomass [Smil, 1984, p. 149]. Even with the use of biomass for fuel, millions of peasants suffer from a fuel shortage for a much as six months per year [Smil, 1984, p. 151]. This shortage has in no small way accelerated the loss of tree cover and exacerbated erosion in the Yanagzi basin [Smil, 1993, p. 106].

During the 1980s, after the reforms allowed private farming for profit, there was hope that fuel wood farming might fill a substantial portion of the rural energy demand. Smil, has argued, however, that due to limitations of water supply, and the vast excess demand for household fuel, it is unlikely that this alternative could make a substantial contribution to the shortage [1993, p.108].

Another solution, biogas, also has limited potential. Biogas (methane) is produced by fermenting phytomass. Since bacterial action is required the productivity of this process is highly sensitive to temperature, thus limiting the year-round use of this technology to the southern provinces [1993, p. 104]. The energy potential of this technology is further limited by the availability of phytomass and the efficiency of the conversion process. For the most part, China's biogas digesters are very inefficient at producing gas, but they do produce a high quality fertilizer as a by-product which is the mainreason they are now used [Smil, 1993, p. 105].

In place of the ancient recycling procedures, China has expanded its production of artificial fertilizers which feed crops, but destroy the soil. China use nearly three times as much artificial nitrogen fertilizer per hectare than is used in the United States, and is second only to Japan [Ecological Agriculture, p. 303, table 1]. But, the classic law of diminishing returns is at work. In 1957, the yield grain in kilograms per kilogram of fertilizer stood at 93.2. By 1985, it had fallen to only 4.7! [Ecological Agriculture, p. 303, table 2]. China is walking the food plank. It has reached the productivity limit of high energy agriculture, and its supply of land is falling.

The root of the problem in China is the doubling of the population in the years following the revolution in 1949. In 1820 the Chinese population numbered 400 million. By 1950, 140 y years later, it had grown to "only" 550 million. By the year 2000, only 40 years later, even after the imposition of Draconian population controls in the 1980s, it had reached 1.1 billion. At present, demographers expect the Chinese population will stabilize at about 1.6 billion by the year 2050.

In 1957, Ma Yinchu, a demographer and the president Beijing University, issued a warning on the threat rapidly growing population posed for the nation's future well-being [Shapiro, p. 22]. Unfortunately, this idea was considered "Mathusian," and, thus, was anathema under Marxist doctrine in both the Soviet Union[76] and in China. Yinchu was silenced, stripped

[76]Malthus, in effect blamed the condition of the poor on high population growth instead of exploitation by capitalists and landlords. In 1796, England's Prime Minster, William Pitt, in anticipation of war with the more populous France, proposed a subsidy for large families. After reading Malthus' essay in 1798, Pitt withdrew the proposal. The ideological rejection of

of his position and forced out of public life, and barely escaped being "stigmatized as a rightist" which might have meant prison and hard labor or worse [Shapiro, p. 22]. At best, Mao's attitude toward intellectuals was one of distrust, and as part of the great Cultural Revolution, they were reduced in status to the "stinking ninth category - the lowest of the low" [Shapiro, p. 25]. Little surprise that an intellectual speaking heresy would so treated.

In 1994, a study authored by Qu Geping, acclaimed as the "father of Chinese environmentalism," blamed the population explosion on the policies of Mao and shows how growing population leads to environmental degradation. Population growth increases economic activity and then increased economic activity produced more population growth. The spiraling level of economic activity produced a cascade of environmental degradation [Shapiro, p.28]. In particular, as population expanded it became necessary to increase the quantity of arable land by land reclamation which means cutting down forests, terracing mountains, opening "waste lands," and filling in lakes and ponds [Shapiro, p. 28, 120]. In the relentless quest to grow more grain, hillsides were terraced and grasslands turned to agriculture. The thin soils on the hillsides was washed away, often to the bare bedrock, and the converted grasslands turned into deserts and China's version of the American "Dust Bowl" [Shapiro, p.107]. In Mongolia alone, millions of acres of grassland has been trend to desert, and dust storms bury another quarter million acres each year [Shapiro, p. 107]. Moreover, some of the land cleared for terraces was bamboo forest which is home to the endangered Panda.

Then there was the program called "encircle the lakes, create farmland" which entailed building dikes and filling in behind them to reclaim lake wetlands [Shapiro]. In a perennially land-starved nation this method of land reclamation had a long history, but the scale of these activities during the Mao years was exceptional. One particular case, that of Dian Lake [*Dianchi*] stands out from all the rest in terms of the magnitude of the effort and the salience of its failure.

Dianchi, with an area of 300 sq/km or about 115 square miles, is the sixth largest freshwater lake in China [Shapiro, p. 116]. The lake is near Kunming, in Yunnan Province. It is said that Kunming has the best climate in all of China [four seasons like spring] and this is attributed to the temperature stabilization provided by the lake [cools in summer, warms in winter]. The lake was once three times its present size [1000 sq/km], but has been filled over the years to create farmland. By 1936 it has been reduced to 360 sq/km. The most recent instance being the 25 sq/km [10 square miles] taken during the Cultural Revolution in 1970 [Shapiro, p. 116].

Malthus was consistent with the political needs of the USSR at the time, but no so with those of China. The Soviet Union lost 22 million people during WWII and thus needed very high rates of population growth to replace this loss. China, unfortunately mimicked the Soviet pronatal policy though it had no such need. Mao viewed people as a great resource, and his "military logic, also necessitated a large population as "military capital." With 600 million people, "even with bomb," Mao boasted to Nehru, "America would be unable to wipe out China" [Shapiro, p.31] . In a conversation with Khrushchev in 1957, Mao admitted that a war with the imperialists might cost 300 million Chinese lives. "So what?," he said. "War is war." "The years will pass and we'll get to work producing more babies than ever before" [quoted in Shapiro, p. 32].

Under the general pressure to increase farm land to feed the burgeoning population, and the additional specific pressures of a possible war with the USSR, a gargantuan effort that mobilized some 300,000 people, including soldiers and virtually everyone in Kunming, the dike was built and the area filled quite rapidly - eight months. Later estimates of labor involved put the total at 24 million labor days [Shapiro, p130]. This effort was made despite the advice of scientists that the dike could not be built and that any land reclaimed would be useless for agriculture. These scientists were dismissed as"foreign capitalist technical authorities" and those Chinese scientists who supported them were criticized as "traitor/ secret agent/ scabs" who followed the "foreign slave philosophy" [Shapiro, p. 127].

As it turned out the old "superstition" that "you can't build good farmland on sludge" proved true. The land was to wet, too soft and too cool to grow grain. Women, trying to harvest rice, would sink into the muddy bottom so that the paddy water level was waist high. Peasants had to use boats to gather in the grain [Shapiro, p. 129]. The farm established on the reclaimed land was closed in1982. The land is now used as a place for a tourist attraction known as "minority village" which features the cultures of all the peoples of Yunnan Province. Moreover, the people of Kunming claim that the weather has deteriorated since the project filled in the wetlands. There is no scientific evidence to support this supposition, but people claim the winters are colder and the summers are hotter.

It is worth noting here that Dianchi has suffered a far worse fate than the loss of wet lands. Over the past thirty years or so, due to an expanding manufacturing sector [the lake is surrounded by 260 manufacturing plants], and population growth in the area, the lake has become an open sewer for untreated industrial and human wastes. Some 20 sq/km of the northern end of the lake are covered with blue-green algae, a certain sign of eutrophication consequent to organic and industrial waste. In 2003, only about 60% of Kunming's sewerage is treated before it is dumped into the lake. The lake also suffers from serious "nonpoint pollution" in the form of fertilizer run-off from the farms in the watershed of the tributaries to the lake [Source: US Embassy - China].

Over $2 billion has been spent to clean up the lake since 1993, but the ultimate goal is modest - to clean the lake to level 4 (out of five with five the worst). At level 4 the water will suitable only for agricultural purposes and non-swimming recreational purposes. The once prolific fishery sustained by the lake will surely never recover [Source: US Embassy - China].

China, it would appear is following the same development path as had Japan, South Korea and Taiwan. In each case, farmland was sacrificed to secure more industrial output. Presumably, following the law of comparative advantage, each nation was able to purchase more food with the proceeds from the export of manufactured goods. The conversion of grain land to alternative uses of manufacturing and development infrastructure cost Japan effectively 52% of its grain land. In South Korea and Taiwan the losses were 46% and 42% respectively [Brown, Who Will Feed China, p. 25]. Of course, some of the loss of land could be offset by increasing productivity on the remaining land, but this did not happen. In Japan, grain output fell by 32% from its 1960 peak. Grain output in Taiwan and South Korea has fallen 24% since the peak in 1977 [Brown, Who Will Feed China, p.25]. In 1994, these countries were importing 71% of their total grain consumption, easily financing it with exports of manufactured goods.

Since the Deng reforms in 1978, China's output of grains has grown impressively and China now ranks with the United States as the world's largest grain producer. Indeed, as Valcav Smil has observed, 'food, in per capita terms, is more abundant, and in general more equitably accessible than at any time in China's long history, but the margin between adequacy and deficit remains slim while the irreplaceable environmental foundations bearing the intensive and continuously intensifying agriculture, now needed to feed 1.2 billion people, have been weakening steadily. The most obvious manifestation has been an enormous shrinkage of per capita availability of farmland"[V. Smil, China's Environmental Crisis, 1992, p. 4]. Thus, while "indicators of human welfare may be rising, [the] environmental foundations of this success show much worrisome wear" [Smil, 1992, p. 9]. Smil list of the "major worries," includes "wind and water erosion of, and the decline in nutrient content and organic matter in agricultural soils,... the salinization and alkalization of irrigated farmland, over-drawing groundwater, and deforestation and desertification. "[1992, p. 10]. Contrary to the assertions of the "cornucopians," there are simply no "satisfactory technical solutions capable of restoring these damaged ecosystems" [p. 10].

Were China the only country experiencing loss of farmland and declining soil fertility, it would nonetheless be a global catastrophe. Feeding China's billions would force up food prices all over the world and produce hunger on a global scale. Even a small percentage shortfall in China's rice crop could exceed the supply of surplus rice on the world market. But, the problem of soil loss and depletion extends far beyond the borders of China.

In 2002, a United Nations Report on the state of global ecosystems noted that "five billion acres of soil, more than the area of the US and Canada" have been "degraded by human activity." Nearly a billion of those acres have been "strongly or extremely degraded" mostly by "wind erosion and excessive grazing" [Andrew Revkin, New York Times, 5/23/02]. Also, the world's soils are being depleted by erosion and pollution from insecticides and herbicides. Two billion tons of topsoil are lost each year through wind and water erosion and threatens up to 1/3 of world crop lands. More than 10% of the world's crop lands show evidence of reduced productivity due to salinization [Postel p. 43]. Overall nearly a quarter of the world's crop land are moderately or strongly degraded [Gardner p. 84]. Over the past few decades increased use of fertilizers has been able to offset declining productivity due to soil exhaustion. But now the application of fertilizers has begun to show diminishing returns and crop yields of grains have been barely rising in the 1990s [Gardner p.84]. Moreover, the run-off of nitrogen and phosphorus into water systems causes serious problems for fisheries. Indeed, leached and eroded fertilizers are the single largest cause of water pollution in the United States. The fertilizer nutrient feed algae which in turn causes eutrophication - fish are deprived of oxygen. Each year as the Mississippi drains into the Gulf of Mexico, a "dead-zone" the size of New Jersey is formed; fish cannot compete with algae that feed on the phosphorus and nitrogen drained from the US corn belt [Gardner p. 85].

Much of the world is also experiencing a loss of soil as it is covered by homes, factories, highways and flooded behind dams built to produce hydroelectric power for distant cities. In China, the Three Gorges Dam, begun in 1994, will flood twenty towns and 11,000 hectares of farmland and displace 1.4 million people. These people will be moved to higher ground where the land is only one-fifth as fertile as the rich river valley land that is being flooded [Sachs in

Brown 1996 p.140].

In Nigeria the once fertile lands of the Niger Delta have been destroyed by the development of oil fields that have turned the local rivers black with oil slicks and poisoned ground water [Sachs p. 140]. In just the past decade infrastructure projects have, by destroying local ecosystems and subsistence bases, displaced as many as 90 million people around the world [Sachs p. 141].

Conservation Tillage

Conservation tillage basically is agriculture without the plow. Land is plowed to control weeds. The cultivation (weed control) that armies of slaves and free farm workers used to do with hoes is now done with tractors and plows. The unfortunate by-product of plowing is loss of soil moisture and loss of soil thorough wind and water erosion. Indeed."tillage is one of the worst things you can do to the soil," says Dr. Charles Rice, professor of microbiology at Kansas State. Conservation tillage advocates using herbicides rather than plowing to control weeds. It has the additional advantages of preserving organic material in soils and the population of commensal insects. Of course, it also requires less labor to prepare fields for crops.

Another advantage is that no-till agriculture promotes the sequestering of carbon in the soil. Some estimates have placed at about 50% the amount of carbon lost from soils by plowing over the past 200 years. As one observer noted, "the Kansas prairie is a great big carbon sponge"[David Barboza, Plan Give Farmers a Role in Fighting Global Warming, New York Times, 11/25/03, p. D3]. Dr. Rice has estimated that with conservation tillage some 20% of the emissions from other sources can be offset [quoted in Barboza]. The potential for mitigating global warming with conservation tillage is so great Senator Pat Roberts of Kansas has proposed a plan to offer farmers a financial incentive to adopt the practice [Barboza]. Of course, eventually the soil would become saturated with carbon and absorb no more, but that would take about 30 years [Barboza].

Biodiversity

In the public mind, the notion of species extinction is framed in terms of what some have called "charismatic megafauna" such as whales, pandas, eagles, gorillas, tigers, leopards, ocelots, jaguars, elephants, the rhinoceros. These admittedly magnificent creatures are hunted relentlessly for their horns and tusks, which are turned into ceremonial swords or aphrodisiacs, their skins which are turned into clothing, for trophies, or for zoos, or in, the case of the whale, as an exotic food. Next to such glorious animals, mere fish, frogs and plants, not to mention bacteria, and plankton seem inconsequential and irrelevant, and surely not worth any expenditure of resources to protect. The problem for most of these megafauna is that they have market value and they are a special type of public good known as a "commons:" consumption of them is rival but, even with various treaties protecting them, poachers cannot be prevented from slaughtering them. The wildlife trade, known as the "extinction business" is still thriving even after the Convention on International Trade in Endangered Species of Wild Flora and Fauna which had been signed by 51 nations by 1980 [Ehrlich & Ehrlich, Extinction, p. 194]. Most of the species in the greatest danger of extinction are found in poor countries which, even should there be an

interest in protection, have little in the way of resources to do so.

As any economist will tell you (ad nauseam), "people respond to incentives." In short, if there is a demand, there will be a supply. Thus, based on the unfounded belief in traditional Chinese medicine that powdered rhino horn has substantial curative and aphrodisiac properties, the price of a rhino horn can be as high as $45,000 per kilo which is nearly four times the price of gold. Little wonder that poaching is driving some rare species of rhinoceros, such as the Sumatran Rhino, into extinction [E.O. Wilson, *Future of Life* , p. 85]. The poachers are well-armed, but more often than not officials and game officers are bribed to look away from the slaughter. Nonetheless, as frustrating and depressing as it may be, the wildlife trade is not the major threat to species around the world, even to the more charismatic ones. The principal threat to biodiversity comes from habitat destruction.

"Species come and species go," it is often said because species extinction is a normal part of life on earth. It is all "part and parcel of the evolutionary process," it is merely "nature's way of experimenting with life"[Ehrlich & Ehrlich, Extinction, p. 7]. Indeed, it is probable that some 95% of all species that ever existed are now extinct [William R. Stevens, Lush Life, New York Times, 6/2/98, p. E1]. Whether due to sudden and dramatic climate change caused, for example, by asteroid collisions, or the migration of continents, or due to the introduction of competitive or predatory species, to mention just a few possibilities, the extinction of species has been a commonplace event in earth history. At least five times in the past 600 million years, there have been mass extinctions where as many as 90% of species have vanished. That said, it is possible that the in geological present there is more variety of life on earth than at any other time [Stevens, 1998, NYT, p. E1]. Yet, many scientists are concerned that a sixth extinction is under way. This one is not the result of a cataclysmic cosmic or geological event, but rather, as the result of the emergence a formidably competitive and predatory species, one that not only hunts other species, but who also deflects vast amounts of energy from other species to its own propagation. That species is, of course, *Homo sapiens*. Humans "harvest wild species to burn, eat or sell; expropriate and destroy wild habitat to make way for human works like farms, cities, suburbs; moving plants and animals around the globe in a mix-and- match game in which a relatively few, superadaptable plant and animal species are crowding out a larger number of less hardy ones" [Stevens 1998, p. E1]. As human numbers grow, and the human appetite for energy becomes even more voracious, the extermination of other species will only accelerate. At present [2002], the World Conservation Union estimates that about 30% of fishes, 21% of amphibians, 25% of reptiles, 12% of birds and 24% of mammals are "threatened" [critically endangered, endangered, and vulnerable]. Also threatened are about 30% of invertebrates and nearly 50% of plants[www.redlist.org].

"The diversity of animal life on Earth has increased from near zero at the beginning of the Cambrian (540 Ma) to some 4-6 million species alive today" [Jeremy Jackson and Kenneth Johnson, Measuring Biodiversity, *Science*, 293, 28 September 2001]. When one adds in the bacteria and viruses, plants, and fungi the number rises into the tens of millions. Indeed, there may be millions more species as yet undiscovered.

The flora and fauna of the world are not evenly distributed over the planet's surface. More than half of the extant plant and animal species live in tropical rainforests, the "headquarters of global biological diversity" as E.O Wilson calls them [Wilson p. 58]. Yet, tropical rainforests constitute only 6% of the earth's surface. E.O Wilson reports finding 43

species of ant on a single tree in the Peruvian Amazon which is about the total number of ant species found in the entire British Isles [Wilson, *The Future of Life*, p. 20].

According to some prominent scientists, Paul Ehrlich, for example, the world in on the verge of a massive species extinction; one that will rival the mass extinction of Dinosaurs 65 million years ago. While the dinosaurs were victims of natural forces, the putative impending extinction will be man-made. It will be the result of habitat destruction, primarily in the tropical rainforests, the introduction of exotic species, over harvesting of animals, fish and plants, and pollution and climate change [World Resources p.147]. According to the National Science Foundation the potential massive extinction could include (1/4) of the earths plants, animals, microbes and fungi [Merchant 1992, p. 21].

Toxic chemicals such as dioxin, trichloroethylene, pesticides in soil and water take their toll on nonhuman and human life [Merchant, 1992 p. 22]. These manmade compounds have no place in the natural world. As scientist, Barry Commoner remarks, "an organic compound that does not occur in nature is one that has been rejected in the course of evolution as incompatible with living systems." But toxins are a relatively unimportant aspect of the massive extinctions.

At the root of the matter is human macroparasitism. In the human past, habitat destruction has accounted for slightly over 1/3 of documented species extinctions. Slightly less than one-fourth of extinction have been caused directly by hunting. About 40% of species extinction have been caused by the introduction by humans of non-native species[77] into a habitat. Pollution and other factors account for less than 2% of species extinctions [Edwards p.212].

All creatures live on solar energy. The global net primary production (NPP) of energy from solar energy is the amount of energy fixed by photosynthesis less the amount required by the plants for their own maintenance . At the moment humans are appropriating some 40% of the NPP produced on land. Humans divert NPP to their own use when they convert forest to crop land or to pasture. Humans also reduce potential NPP when they turn rainforests into pastures or land into deserts or parking lots, highways and suburbs. The more NNP absorbed or destroyed by humans the less is available to other species [Ehrlich & Ehrlich p. 134].

Over the next 50 years we can expect population to grow, perhaps to double, and for economic development to accelerate, by a factor of 5 to 10. The effects of this increase in human macroparasitism for other species will be nothing short of catastrophic [Ehrlich & Ehrlich p.35] The likelihood of species extinction in the face of development is enhanced because most species live in habitats that are the "predominant resources available to rural poor people" of the equatorial and sub-equatorial zones [Edwards p. 220, 224]. These species are in the path of "hundreds of millions of rural people in developing countries" who because of poverty are "compelled to destroy the resources necessary to free them from starvation" [Edwards p. 223].

The potential massive loss of biodiversity has so alarmed biologists that many have

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[77] For example, when Europeans brought their animals to the new world their foraging patterns changed the distribution of flora. Even worse these animals had “old world” seeds in their guts which they excreted. The new weeds and grasses displaced the native weeds and grasses. The patterns were repeated with rodents, insects and other life forms.

organized a new discipline called conservation biology. Conservation biology is more than a reaction of biologists to the loss of their subject matter. Humans take very real risks when they kill-off species because every species plays a role in sustaining an ecosystem. Changing ecosystems may have deleterious effects on humans. Most obviously, if human activities extinguish a species that has acted as a control on a disease vector or a crop eating insect humans will be adversely affected. Moreover, there may be many plants that have valuable medicinal uses that may become extinct before we even know they exist.

Is most important to comprehend that species are not discrete entities. Every species is linked to a community that is called an ecosystem [e.g. rainforest, estuary, lake, alpine forest, coral reef, kelp forest]. Each species is linked to others in a way that in some sense harmonizes and balances the system. Each species is linked to its community "by the way it variously consumes, is consumed, competes or cooperates with other species" [Wilson, p. 11]. For example, in the northern Pacific kelp forest ecosystem, herbivorous sea urchins fed on the kelp, sea otters fed on the sea urchins and each population prospered. The predation of the sea urchins by the otters prevented the former for "overgrazing" the kelp [Jeremy Jackson et al, Historical Overfishing and the Recent Collapse of Coastal Ecosystems, *Science* 293, 27 July 2001, p. 631]. Human aboriginals began to hunt sea otters for subsistence purposes some 2500 B.P.. The ecosystem was impacted but in a limited way due to the small size of aboriginal population (Aleuts) and its limited technology. Unfortunately, when better equipped, and commercially driven humans entered this ecosystem, the otter was hunted close to extinction. In the 1800s, fur traders hunted otters, not for subsistence, but for their commercially valuable skins [Jackson et al, p. 631]. Uncontrolled by the predation of sea otters, the Kelp forest was consumed by the burgeoning population of sea urchins. Eventually the sea urchin population crashed as their food source was depleted.

Like the individuals within any species that comprise an ecosystem, ecosystems do not stand alone as discrete units either. Each ecosystem is connected to the "dynamical network of organisms, materials and energy" that we call the biosphere [Wilson, p. 11]. Some species may have only a limited impact in a single ecosystem while others may play a "keystone role," e.g. the sea otters in the Pacific kelp forest. Yet, others may have a "measurable global impact"[Wilson, Future of Life, p. 11]. Oceanic phytoplankton, for example, play a key role in the control of the global climate [Wilson, p. 11]. Bacteria in the soil that "fix" nitrogen are everywhere essential to agriculture in particular, and plant growth in general.

Ecosystem behavior is dynamic, evolutionary rather than mechanistic, and thus "exhibits a limited degree of predictability" [Costanza et al, p. 94]. Ecosystems follow their own internal logic of "succession," but due either to this internal logic or a perturbation from outside, e.g. a fire, the system may "reorganize." The "resilience" of the system will determine what follows from the perturbation. For example, a rainforest ecosystem may bounce back from a fire, indeed, fires are a critical internal element in rainforest ecology. On the other hand, rainforests are not resilient after clear-cutting has opened a gap in the canopy. Water and wind erosion quicky strip the open space of soil before it can be reseeded [Wilson, Future, p.63]. Even worse, clearing the rainforest leads to an increase in desiccating winds which increase the normally humid forest's vulnerability to fire. In short, humans cannot rely on ecosystems to remain stable in the face of perturbations caused by human activities.

Ecological systems, that is the communities of plants animals and microorganisms, as

they interact with each other and the physical and chemical environment are, in effect, the fundament of life support on earth. Without the services of this life-support system, "economic activity would be impossible"[Robert Costanza et al, 1997, *An Introduction to Ecological Economics*, p.95]. "Ecological services are those ecosystem functions that are currently perceived to support and protect human activities or affect human well-being. They include maintenance of the composition of the atmosphere, amelioration and stability of climate, flood controls and drinking water supply, waste assimilation, recycling of nutrients, generation of soils, pollination of crops, provision of food, maintenance of species and a vast genetic library, and also maintenance of the scenery of the landscape, recreational sites, aesthetic and amenity values [Costanza et al, p. 95]. To the extent that human activities perturb the ecosystems that produce this multitude of very valuable services, humans run a grave risk of having ecosystems "reorganize" in ways that are less amenable to human exploitation. So, one might ask, what is the degree of risk, what does humanity have to lose, or E.O. Wilson has put it, "How much is the biosphere worth?"[Wilson, 2002, p. 103].

In 1997, a group of 12 ecological economists published "The value of world's ecosystem services and natural capital" in the journal *Nature* [387, 253-260]. The paper estimated a value on global ecosystem services of $33Trillion per year (38 trillion $US2000), which is close the value of Gross World Product [Andrew Balmford et al, Economic Reasons for Conserving Wild Nature, *Science*, 297 (9 August 2002), p. 950]. Needless to say, this paper has generated a cascade of criticism from those who think the estimate is too low, and from those who think it is simply speculative and irrelevant for decision making purposes.

Some critics have claimed that the paper's findings are unsupportable on both logical and empirical grounds [see Briefing: Ecology and Economics, *Nature*, 395, October 1998, p. 430]. Obviously, the study had to make many assumptions and make many approximations to fill in

The value of the ecological services provided by flora and fauna is often taken for granted until they suddenly disappear. For example, India which has benefitted for millennia from the "disposal services" provided by vultures is now in crisis because, for some reason(s) yet fully understood, some 96% of vultures have suddenly died. India has relied on vultures to dispose of the carcasses of dead animals, mostly sacred cows, but also other animals (bullocks and domesticated water buffalo) used for traction in agriculture. The sacred cows wander the land and, since it a sacrilege to touch them, they are left where they die. Other animals are carried to centralized sites and left for the vultures.

Adult vultures are dying at prodigious rates. After their heads droop for a while, they simply fall from their perches. One of the first suspects was DDT poisoning. India , and China,, one might add, produce and use vast quantities of DDT to control malaria. Consequently, every creature in India carries a heavy burden of DDT. The typical Indian has a body burden of DDT of 22.8 ppm compared to 4.3ppm in Japan and 2.24 ppm in the United States. Since DDT bioaccumulates in body fat, and since vultures are at the top of the food chain, it was logical to suspect DDT. However, DDT has been ruled out for two reasons. First, the tissue burden in vultures was not very high. Second, the demonstrated harmful effects of DDT on birds are in egg development, it does not cause adult mortality. The major suspect now is a virus that impacts on kidney function; many of the dead birds seem to have gout. The disease is spreading from east to west and it is feared that it may find its way off the Eurasian continent into Africa. The sudden emergence of a viral epidemic like this suggests and anthropogenic origin. Just as the spread of HIV followed changes in humans sexual behavior, one expects that the rapid spread of this avian virus had its etiology in some human behavioral change. One possibility is that the massing of large number of birds at human created "carrion dumps" may have facilitated the spread of the virus, but the mystery remains. It seems likely that three species of vulture will be extinguished in India, and perhaps all over the world.

In any case, India has a problem. The rotting carcasses increase the risk of outbreaks of anthrax, tuberculosis, and foot and mouth disease and rabies. The last is due to the explosion in the population of feral dogs that is quite literally being fed by the mountains of animal carcasses accumulating all over India. Packs of feral dogs, in some cases, numbering as many of one thousand, are a menace to humans and

the holes in the data. The research consisted of using case studies to derive average values of each of 17 ecological services in 16 biomes. The study then used "averages" for one "case" biome and imputed that average to other biomes for purposes of global aggregation [Balmford, p. 950]. Thus, in terms of policy formation in any given locality, the measure may be a poor indicator of value [Briefing, p. 430].

On the level of logic, environmental economists complain that value is relative. First, economists are concerned only with marginal value, not total value. Thus, from a microeconomic policy perspective total value is meaningless. If one is deciding whether to convert 100 hectares of Honduran rain forest into cattle pasture, for policy purposes, what we need to know is the value of ecological services from say 100 hectares of rainforest in Honduras, not the total value of the Honduran Rain Forest.

The proper conception of the problem is one of cost-benefit analysis. In cost-benefit analysis the total net benefit of "good" is the consumer surplus produced by the good - the excess of value, as perceived by the consumer over the opportunity cost to the consumer of purchasing the good. To measure consumer surplus we need to know the price elasticity of

demand for the product (roughly what the demand curve looks like). In a normal market, the price is equal to the benefit of the last unit consumed and is thus dependent on the quantity consumed. If the law of demand (diminishing marginal utility) is operative, inframarginal units will have higher valuations. Thus, should public project increase the supply of a good or service, the proper measure of its benefit is not the P X Q but the addition to consumer surplus (the excess of valuation over price integrated over the range of the increase in output.

Analogously, the total net benefit of an environmental service is the excess of its value over opportunity cost integrated along the relevant quantity dimension. The opportunity cost of the ecological service would be indicated by the best alternative use of the resource. If we assume constant marginal opportunity costs, we would measure total opportunity cost the area P=MC x Q where Q is the quantity of ecological service and P is its price or valuation at the margin. It is not uncommon, however, for cost-benefit analysts to mistakenly use this as a measure of total benefit. Indeed, this is exactly what Costanza et al do - they take the marginal value of an environmental service, measured per hectare and multiply it by the number of hectares. Unless the demand curve for this service happened to be perfectly horizontal, this procedure measured only part of the total benefit.

To see this let us examine the case of the disappearing vultures in India (see box). When vultures were plentiful one can presume the marginal valuation of their "clean-up" services was quite low, even thought the total value was quite high. As the number of vultures declined, one can be sure that the "willingness to pay" for their services at the margin surely increased especially as India considered the replacement cost of these services. Since there was virtually no opportunity cost for sustaining the vulture population, the total net benefits would be measured by the entire area under the demand curve. Clearly, then the Constanza et al methodology underestimated, at least conceptually, the *total benefits* of ecological services. The Constanza et al study makes no attempt to measure the net benefits of ecological services as no consideration is given to the opportunity costs ecological services.

While each of these microeconomic criticisms may have merit, they really miss the macroeconomic point. Constanza et al have done little more than standard macroeconomic GDP (P x Q) accounting to estimate the total value of these nonmarket services. They recognize that their number is not definitive, but it is "better than no number at all" and it shows that most economists were vastly underestimating the value ecosystem services by several orders of magnitude [Briefing, p. 430]. Because values are imputed they are to some extent arbitrary and surely no one is contemplating any policy that might involve replacing all of our natural capital with man-made capital. But, whatever the technical flaws, the paper has drawn attention to "large-scale problems." Given the global nature of many ecological problems and the unpredictability of ecosystem dynamics such a perspective shift is not only desirable it is necessary.

If the issue is the conservation of "wild nature" or more specifically the current level of ecosystem services provided by ecosystems, then it is really a matter of benefits and costs. In short, one must recognize that the preservation of "wild nature" precludes some form of development option [Balmford et al, p.950]. Indeed, were there no benefits to be had by destroying "wild nature" it would probably have been left alone.

A rainforest has competing uses. For example, it can be used by aboriginal peoples to

sustainably extract forest products some of which may be directly consumed, or sold. To the aboriginal people the value of forest services is properly measured by the "value" of these products. To people outside the forest, however, there is another "value" - that of carbon sequestration. It is generally held that the latter "global value" far exceeds the local value [Ricardo Gordoy et al, Valuation of consumption and sale of forest goods from a Central American rainforest, *Nature*, 406, July 2000, p. 63]. The "value" conflict emerges when the aboriginal peoples, or more likely a distant government, decides that clearing the forest for agriculture, ranching or lumbering may produce more value *to them*. More broadly then, when considering the value of ecological services across biomes, one should consider not the total benefits of ecological services, but rather the "difference in benefit flows between relatively intact and converted versions of those biomes" [Balmford et al, p. 950]. Of course, it goes almost without saying, that should such values prove positive, that is, the value of a forest's ecological services exceeds its value in its best converted use, it is no guarantee that the forest will be preserved. In most cases, a substantial portion of the benefits of ecological services take the form of "nonmarketed externalities accruing to society at local and global levels," and even should reliable information as to their value exist, there maybe no institutional framework to insure that private, local incentives do not dominate the decision [Balmford et al, p. 952].

To answer the question as to whether the value of ecological services of intact biomes exceeded that of biomes converted to other uses, Balmford et al reviewed some 300 case studies of biomes around the world. Only studies that included estimates of ecological services from an intact biome and the value of the biome in alternative uses we selected. The four biomes selected were Tropical forest (Malaysia, & Cameroon) where the opportunity cost was logging, Mangrove (Thailand) where the opportunity cost was aquaculture (shrimp farming) , Coral Reef (Philippines) where destructive fishing was the alternative to sustainable fishing, and Wetland (Canada) where intensive farming was the alternative. "In every case," the study reported, "the loss of nonmarketed services outweighs the marketed marginal benefits of conversion, often by a considerable amount" [p. 951]. Thus, the study concludes, from the "perspective of global sustainability" whatever the rationality of past conversions might have been, "the conversion of remaining habitat for agriculture, aquaculture, or forestry does not make sense"[p. 951]. Indeed, the advantages of conservation are so impressive, "that our (estimate of) service benefits and costs would have to be off by a factor of 100 for conservation "to not make sense." [p. 953].

Can the invisible hand save nature?

We believe in equal opportunity regardless of race, creed, gender, kingdom, phylum, class, order, family, genus, or species. All life is interconnected. So without a supporting cast of millions of species human survival is far from guaranteed. This variety and interdependence of species is what's called biodiversity - Monsanto Company in an advertisement in the New York Times announcing Monsanto's support of the Hall of Biodiversity in the Museum of Natural History - 1998.

On its face, the above statement by Monsanto, or at least the first two sentences, might be seen to manifest what E.O. Wilson has called *biophilia*, and thought to be a succinctly stated version of what is known as the *ecocentric* ethic - other species have intrinsic value and a right

to survive. Coming from a well known perpetrator of environmental crimes e.g. its poisoning of Anniston, Alabama with pcbs, the statement seems at best incongruous, and at its worst, profoundly cynical. As one reads on, however, one's dissonance dissipates as *anthropocentrism* emerges, i.e. other species are reduced to the "supporting cast" and human survival becomes the paramount value. Subsequent sentences reveal Monsanto's true agenda - profit. "Monsanto's business," we read, "depends on making discoveries in the world of genetic information." And, "information is lost forever when a species becomes extinct." As such information "offers solutions in agriculture, nutrition and medicine" from which Monsanto can profit, its loss is surely regrettable.

Here we have yet another example of what Adam Smith taught the world in 1776, private greed produces salutary public outcomes - the greed of Monsanto, and others like it, for profit saves the tropical rainforest. In 1998, Merck, a pharmaceutical producer, knowing well that one in four drugs is derived from plants[78], paid Costa Rica to preserve what was left of it rainforest, in the form of a system of "Conservation Areas," and offered to share the profits from any medicinal drugs discovered. Hence, the desire for profit has saved the flora and fauna of the Costa Rican rainforest, and one should add the habitat of several groups of indigenous people. It is after all, precisely these indigenous people who, within their storehouse of knowledge (which we call ethnobotany), hold the secrets to the medicinal properties of wild flora and fauna and of specific breeds of agricultural products such as maize.

The potential for humanity to benefit from the "information" in the ethnobotany of indigenous peoples around the world is enormous. Little wonder then that the National Cancer Institute is "bioprospecting" in the tropical forests of Africa and Madagascar and Bristol-Meyers, in conjunction with Virginia Polytechnic University, is doing the same in Suriname. Cures for various types of cancer, and HIV infection derived from plants, pain killers derived from frog skin poison and snake venom and antibiotics produced from soil fungi and viruses called bacteriophages are all on the agenda. There is, however, one very large "fly in this ointment" - Qui Bono?

Knowledge is a public good, that is, its consumption is nonrival - once the medicinal properties of a plant are known anyone can put that knowledge to use at no cost to anyone else. The knowledge of the medicinal properties of flora and fauna, as we have seen, has spectacular value. Yet, it is the nature of public goods that no party can profit from providing them and hence no benefits are derived by the community. The reason for this is that others cannot be "excluded" from using the knowledge to produce competitive products. Competition will drive economic profits to zero or even to losses when fixed costs are high. In the absence of such institutional innovation, "information" will remain the sole domain of Shamans and indigenous horticulturalists.

The economist's answer to this dilemma is the establishment of intellectual property rights. In effect, institutions are established to grant and enforce a monopoly over the right to use a specific piece of knowledge. While still essentially nonrival, the good now becomes "excludable" and hence acquires a degree of "privateness" sufficient to produce profits. Thus, Monsanto, and any universities, and scientists involved in developing the "knowledge," by way

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[78]More than 50% of the most widely used prescription drugs are derivatives of plants. Annual sales of drugs derivative of plants is about $40 billion [Sierra, May 2000].

of enforced patent rights, are assured a monopoly profit for any new drug it develops. The idea that Universities are social institutions, the purpose of which is the creation and dissemination of knowledge for the public good has long passed. The course of science is now directed, to a distressing extent, by the profit motive.

An editorial published in *Science* in 2003 suggests that Intellectual Property (IP) policies of universities are not "serving the public." It is time, the editorial contends, "to ask some hard questions about the university patenting and licensing rush that has emerged" since facilitating federal legislation was passed in 1984 [299, 24 January, 2003, p. 473]. Not only has the university's image as a producer of knowledge for the public good been undermined, the very type of research undertaken by scientists has been distorted into "commercial directions," that is toward finding "marketable products" [p. 473]. Research directed toward products that might"bring only modest profits because it will affect "only small numbers of people, or crops that grow on small acreage" is eschewed [p.473]. Moreover, even when the product does serve many, IP policies slow the development of new products. For example, the development of beta-carotene rich, "golden rice" was delayed as the details of 16 patents and some 72 other "IP barriers" were worked out. In the meantime, millions of people in third works countries continued to suffer from a deficiency of this substance. The editorial, written by Roger N. Beachy, President of the Danforth Plan Science Center, warns that it is "morally unacceptable" that delays in the implementation of scientific advances that improve health and nutrition and protect against disease, be delayed by squabbles over IP issues [p.473].

Finally, with the profit motive driving research, it is less likely that the needs of poor nations will be served, and even should such products be useful to poor countries they will not, as a consequence of monopolistic pricing, be able to afford them. The editorial urges that university IP policies be modified to encourage research "targeted to the public good" and that will be "available for use in developing countries"[p. 473]. Of course, the unwritten subtext of this editorial is the case of Africa where millions are afflicted with HIV infection and who will die because they cannot afford anti-retroviral drugs. The Bush Administration's promise, made in early 3 of $15 Billion in aid to Africa over the next 5 years, aside from enhancing the profits of the Pharmaceutical companies, will help many people suffering form HIV, but it would help many more if the drugs were less expensive.

Even the National Park Service has entered the game. Enzymes found in a microbe in a hot spring at Yellowstone, in 1966, were integral to the development of the polymerase chain reaction, that has allowed the replication of DNA. DNA testing is now a $100 million a year industry, but Yellowstone did not get a cent in royalties. The Yellowstone Park Foundation will now require any scientist or company who uses the properties of Thermophiles (bacteria that thrive in very hot environments like the hot springs of Yellowstone and thermal vents found on the ocean floor) or any other creature or plant found in Yellowstone's relatively unique environment, to share the profits with the Park Foundation.

Sharing the profits surely seems fair. The indigenous people surely think so, but they are conflicted on the issue.

While patents (monopolies) on "information" will produce more profit for all concerned, indigenous peoples along with Third World peoples are organizing against "corporate patenting of living things" [Martin Khor, Third World Network, A Worldwide Fight against Biopiracy, p. 1/5]. The objection stems from three factors. First, the corporations are not sharing the massive profits they are earning from their use of the knowledge and biological resources of Third World communities and indigenous peoples. In short, indigenous people's want their intellectual

> E.O Wilson recounts the tale of how close humanity came to losing a new anti-HIV drug. In 1987, botanist John Burley was collecting samples of plants in a swamp forest in Malaysia for the National Cancer Institute. One such sample came from a randomly selected tree, a species of Calophyllum. The substance derived from the tree was found to have no cancer fighting properties, but it proved to be a powerful HIV inhibitor. More of the substance from the tree was now required to isolate and identify the active substance. When researchers returned to sample the tree, it was gone. It was probably cut by the indigenes for firewood or building materials. Samples from other Calophyllum trees in the area were found to be lacking the substance that inhibited the HIV virus. The original tree was a rare strain of Callophyllum, and it was the only one in the forest. An intense search for another wild individual yielded nothing. Fortunately, a speci,in was found in a botanical garden in Singapore. The active substance was derived and synthesized. It is something called (+)-calanolide A and it is a obstructs the production of an enzyme called reverse transcriptase, an enzyme the retrovirus needs to replicate. The drug is now under study to determine its feasibility and safety for human use - E.O. Wilson, The Future of Life, 2002, pp. 1124-125

property rights to be recognized.

In 1992, the Convention on Biological Diversity was enacted at the Earth Summit in Rio in 1992. The purpose of the agreement was to "conserve and exploit the diversity of species on earth"[Andrew Revkin, Biologists Sought Treaty; Now they Fault It, New York Times, May 7, 2002]. The treaty calls for "national surveys of fauna and floras, the establishment of parks and reserves, and the assessment and protection of endangered species"[Wilson, Future of Life, p. 185]. The treaty has been ratified by 178 countries, the United States excepted. The Clinton Administration signed the treaty, but it was not ever ratified by the U.S. Senate due to intense lobbying against it by the agribusiness and pharmaceutical lobbies.

Discovery of new drugs for the benefit of humanity is completely legitimate. But we oppose what's behind the research, which is the drive for patents and establishing exclusive, monopoly rights to biological resources - Lucia Gallardo, *Accion Ecologica*, Ecuador

The Convention has raised into stark relief the relationship between the issue of the conservation of biological diversity, sustainable use of its components, which include genetic resources, and the issue of the "fair and equitable sharing of the benefits arising out of the utilization of genetic resources"[Article 1, "Objectives"]. While the Convention itself has not changed international law regarding intellectual property rights, it has changed the perspective in this area. Most significantly, the underlying principle under which the issues are not discussed has shifted from the so-called "common heritage" to the "common concern" principle. In the former it was held that "genetic resources are a heritage of mankind and consequently should be available without restriction." In short, genetic knowledge is a public good and should be made

available freely to all. Under the "common concern" principle, national sovereignty intercedes between the information and the interests of mankind. It is allowed that states restrict access to "collectors" and extract consideration in some form for "permits." The consideration is to be shared among local communities, farmers and the government. The new principles are particularly considerate of the interests of rights of indigenous communities over their traditional ethnobotanical resources. In short, exclusion mechanisms, the goal of which is to ensure and "fair" distribution of the profits from bioprospecting are legitimized, even at the expense of the maximal distribution of the benefits of such knowledge to "mankind.".

While it was biologists as a group that pushed for the treaty, they are somewhat nonplused and exasperated by the outcome. Unfortunately, Article 3 of the convention which gave each nation the sovereign right to exploit its own resources, rather than facilitating the protection of biodiversity, has produced a focus on "biology as property" and "spawned paralyzing biological bureaucracies built on the widespread belief that any scientist collecting samples - -whether for a drug company or a dissertation - is bent on stealing genetic material and making a fortune"[Revkin, Biologists Sought... NYT, May 7, 2002]. "Something that was well intentioned and needed has been taken to an illogical extreme" laments the curator of the Amazon section of the New York Botanical Garden. "The net result has been that its kept biologists out of the forest." [Douglas Daly quoted in Revkin, NYT, May 7, 2002]. Dr. Mark Plotkin, an ethnobotanist of some repute, claims that the "rhetoric" of the Convention "ran away from the reality and the whole thing has backfired. We have not found new drugs. The fact that the whole idea is deeply flawed is never questioned" [quoted by Jon Christensen, Scientist at Work: Mark J. Plotkin; A Romance With a Rain Forest and its Evasive Miracles, *New York Times*, 11/30/1999]

In practice, the distinction between basic science and bioprospecting, because it is a difficult call at best, has been lost. In 2002, still Brazil smarting from the pain of losing its monopoly on natural rubber after the British smuggled out seeds to the rubber tree and planted them in Malaysia, and under enormous pressure from the "shamans and elders of 230 indigenous peoples,"prohibited the export of any type of biological sample, for any purpose [Larry Rother, Brazil Moves to Protect Jungle Plants from Foreign Biopiracy, *New York Times*, 12/23/2001]. Given that Brazil is home to about 25% of the world's plant species, this is an obstruction of no little consequence to conservation biologists. Brazil has built it own Amazon Biotechnology Center in Manaus for the purpose of exploiting its biodiversity

A second source of concern is whatever patent rights corporations acquire to indigenous agricultural and medicinal knowledge might be used to prevent Third World people from using traditional methods of healing and agriculture. For example, a patent on an insecticide derived from the neem tree held by the W.R. Grace Company will prevent millions of Indian farmers from extracting the substance even though millions of farmers have been doing it for millennia [Khor, p. 2/5]. In Chiapas, Mexico farmers fear that patents taken out by DuPont on certain types of maize may result in Mayan farmers having to pay royalties to Dupont for maize that was developed, over the millennia, by the Aztec and Mayan peoples in Mexico and Central America.

Thirdly, there is opposition, on ethical grounds, to what has been called the "ultimate commodification of life" [Khor, p.3/5]. The patenting of living things is not restricted to plants and animals, it also includes human genetic materials, and these may prove very valuable.

Indigenous peoples have lived a relatively isolated existence, and hence, may have evolved certain unique genetic qualities. Just recently, for example, there was an attempt to patent the "cell line," in effect the DNA code, of a Guyami Indian (Panama) woman. The woman's cells had interesting anti-viral properties. The woman surely did not give her permission, nor did she know her blood would be used for such research purposes. Were this application not serendipitously discovered by a researcher, it would have surely been granted. Thus, "after having dominated most of the mineral and vegetative resources of indigenous peoples, we are now talking about turning their very bodies as the ultimate resource to exploit."[Philip Bereano, Patent Pending: The Race to Own DNA, Seattle Times 8/27/95, p. B5]. In a similar vein, U.S. scientists have proposed a Human Genome Diversity Project to test the people in "722 indigenous or isolated communities... before they disappear as integral units"[P. Bereano, p. B5]. While posed as a purely intellectual enterprise, it is not unrealistic to expect that there would be intense pressure to commercialize any discoveries.

Clearly the "ecocentric" ideal that "conservation should be a spiritual exercise first and foremost, a moral exercise" has given way to purely "utilitarian" anthropocentric motives [Mark J. Plotkin, author of *Tales of a Shaman's Apprentice: An Ethnobotanist Searches for New Medicines in the Amazon Rainforest,* and *Bioprospecting: Medicine Quest*, quoted by www.actionbioscience.org/biodiversity/plotkin.html]. But, the situation is not only an ethical matter. Because of the monopolization of knowledge, the price of the new "information" advances will be inflated so that many millions will not be able to afford them

Greed is not unique to Monsanto and Merck. Other profit-driven companies want to use the rainforest for timber to be used for everything from furniture to chopsticks, or for minerals, or for ranching and agriculture, and in these instances, the implications for biodiversity are considerably less than salutary. It was hoped that the Convention on Biological Diversity would protect rainforests and other biologically important ecosystems from the ravages of such exploitation. By holding out the prospect of profits from conserving biodiversity, it was hoped that conservation could be harnessed to greed. Now biologists, such as Dr. George Amato, director of conservation genetics at the Bronx Zoo, are claiming that the idea was "totally oversold" [quoted by Revkin, NYT, May 7, 2002]. The by- product of the biodiversity gold rush has been the virtual exclusion of scientists from many important ecosystems and a consequent decline in important ecological research.

In the final analysis, reliance on utilitarian forces to protect biodiversity is in danger of failing because either the medical miracles and the miracle seeds are simply not there. In short, as David Simpson, a senior research fellow at Resources for the Future, has asserted, the "potential returns to bioprospecting have been exaggerated" [Quoted by Peter Passell, Economists Point to Values Beyond Price, New York Times, 6/12/1998]. If biodiversity is to be preserved it will have to be on the basis of other than utilitarian values. The problem is that ecocentric values that attribute intrinsic worth, that is, non-use value, to biodiversity are more likely to be found in the affluent developed nations. Poor nations, on the other hand, are the custodians of the important biodiverse habitats and they may find the latter more valuable in alternative uses. The big question is, "can market-driven incentives to conserve biodiversity be sufficient to the task?" On this point, Economists tend to be skeptical.

The basic fact undermining the value of any individual plant is that they are not scarce. For example, a plant that harbor the miracle substance may grow over a large area of rainforest.

Thus, the value of preserving any particular acre of rainforest is quite low. A Resources for the future study priced 18 rainforests around the world in terms of bioprospecting and came up with values ranging from $8 to $.40 per acre. Thus, what will be offered for bioprospecting rights will be typically quite low and surely not enough to be competitive with alternative uses such as agriculture, ranching or timber. Of course, there are other use values produced in rainforests. Indigenous and other forest peoples extract value in a sustainable manner. Leaving the rainforest to such sustainable uses may be the best long-term use of the "resource" even by utilitarian criteria, but debt-ridden poor nations with exploding populations are not likely to function according to long-run principles.

Animal Rights

The mainstream environmental movement and even the radical fringe generally limit their concerns about animals to issues of extinction or as part of a broader concern with wilderness destruction. They generally ignore issues revolving around the "factory farming" of animals and the use/abuse of animals in military and scientific laboratories. Similarly, the animal rights movement has generally not extended its interests to broader environmental issues [Seager p. 207]. Feminists, however, have developed theoretical frameworks that have linked the oppression of animals and the oppression of women. We will return to this issue in our discussion of Ecofeminism.

Toxic Wastes

Nothing is created out of that which does not exist; for if it were, everything would be created out of everything with no need of seeds. And again, if that which disappears were destroyed into that which did not exist, all things would have perished, since that into which they were dissolved would not exist -Epicurius - 3rd century B. C.

The Second Law of Human Ecology: "There's no away to throw to." - Garrett Hardin

However, arrogant humanity may have become it must face certain ecological realities. One of them, quoted above, is that in the physical world there is no place to hide the toxic by-products of human subsistence activities, including human waste. As Herman Daly has noted, "Since matter and energy cannot be created, production inputs must be taken from the environment, which leads to depletion" and "since matter and energy cannot be destroyed, and equal amount of matter and energy in the form of waste must be returned to the environment, leading to pollution [quoted in Catton p. 205]. Humans are now faced with both the problem of producing an adequate supply of food and by the "more formidable challenge of finding adequate absorptive capacity for the exponentially growing inventory of human-generated wastes [Hardin p. 53].

The total damage done to humans by the waste products of human life are beyond

reasonable estimation simply because we do not understand how many of these wastes affect humans, or to what extent humans are exposed to them and therefore we have been unable to determine the magnitude of the damage. It is also very difficult to prove by both scientific and legal standards that an environmental toxin is the cause of a given disease or syndrome. However, what has been gleaned from studies to date is not encouraging.

For example, in 1981 two British epidemiologists concluded that "approximately 8% of all cancers in the United States could be attributed to workplace and general environmental exposure to human made-carcinogens, accounting for 53,000 excess deaths each year" [De Perna p. 38]. While this number is quite a bit below the number of people who die from lung cancer and other smoking related health problems (300,000) it is not a trivial amount. Moreover, the relative small aggregate is of little comfort to a neighborhood of mothers watching eight of their children die from leukemia as they did in Woburn Mass in the 1970s.

According to the Environmental Protection Agency (EPA) about 80 billion tons of toxic waste are produced each year in the United States [DePerna p. 86]. Over the years these wastes have been disposed of none to carefully in lagoons or in buried barrels or simply left on the surface or dumped into rivers or lakes. The EPA has identified some 22,000 toxic waste sites that are potentially poisoning the water and air of millions of Americans [De Perna p.10].

The Dupont chemical company once used the theme "better living through chemistry" to promote its products. Beginning after WWII with plastic (polyvinyl chloride or PVC); and continuing with pesticides and thousands of new chemicals such as PCBs and Dioxin, industry has produced thousands of new substances. While there is little doubt that chemistry has made a great contribution to the quality of human life, it has not been a contribution that was free of costs. It was not very long before the toxicity of these substances was noticed.

As early as 1974 a possible link between PVC and elevated liver cancer rates of workers in contact with PVC was observed. Shortly, tests conducted on animals confirmed the carcinogenic effects of VC [Bellini p. 14]. Not only workers were exposed to Vinyl Chloride. Vinyl chloride was widely used as a propellant in aerosol cans for a wide variety of consumer products. Users of these propellants were exposed to VC at levels far in excess of doses that had been shown to produced tumors in animals. Subsequent research found a variety of symptoms emanating from contact with VC which came to be called "vinyl chloride disease"[79][Bellini p. 17]. The EPA has rated VC a "Class A Carcinogen.[80]

Consumers are exposed to VC in the air and water from multiple sources everyday. That great "new car smell," for example, and simply be the "outgassing" of vinyl chloride from all the plastic parts. VC is in consumer products from carpets to counter tops. VC alter enters drinking water from PVC pipes, plastic bottles and so on.

Vinyl chloride is just one among many such toxic substances created to better our lives through the magic of chemistry.

While the industry knew from studies done by their own physicians, that exposure to

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[79]Symptoms of acute exposure include dizziness, drowsiness and headaches. Long term exposure may cause a rare form of liver disease and Raynaud's disease (extreme sensitivity to cold).

[80] A Class A carcinogen is one for which the epidemiological evidence and the animal studies are sufficient to prove an increased risk of cancer from exposure. Class B carcinogens or "probable carcinogens" have sufficient animal evidence but insufficient epidemiological evidence.

vinyl chloride may cause liver cancer and other maladies such as "bone absorption" in its workers, it conspired to keep such information from the government and the public. It could not ignore the cancer risk to consumers from hair sprays and other products that used vinyl chloride gas as a propellant. The liability of the producers for the cancers caused in workers was limited by the workmen's compensation laws, and the number of workers was relatively small. There was, however, no limit on the potential liability exposure for consumer injury, and the number of consumers was large. Given the potential exposure many companies quietly quit the production of vinyl chloride gas for propellants without, of course, notifying the government or the public why they were doing so. Here is a clear case of how potential tort liability forced a company to act responsibly. While there can be argument as to whether the tort system has been abused, it has nonetheless been an important source of consumer protection in many cases. Indeed, as we shall see later, abuses aside, there are serious deficiencies in the tort system as a means of consumer protection from toxic wastes and products that expose consumers to toxic substances.

Polychlorinatedbiphenyl (PCB) is another chlorinated hydrocarbon product that is widely used in industry. PCB is non-flamable and very stable. It is used in non-flamable cooling compounds, hydraulic fluids, wood preservatives and plastics. It is used now only as a coolant in electrical transformers. A close relative compound, dioxin (PCDD), is found in some preservatives and in herbicides, the most well-known being Agent Orange, a defoliant used in Viet Nam. Agent Orange (the herbicide's 55 gal drums were coded with an orange stripe) is suspected of damaging the health of U.S. troops. PCDD was not an ingredient, but rather was a contaminant in the Agent Orange.

Among the illness claimed to have been caused by the dioxin-laced defoliant were various cancers, skin diseases and birth defects in children [De Perna p. 221]. A review of the evidence by the National Academy of Sciences in 1996 found that there was either sufficient or limited/ sufficient evidence to justify linking many diseases, including several forms of cancer, with agent orange exposure.[81]

The US Code prohibits suing the US Government for damages incurred in military service. A class action suit brought against the manufacturers of Agent Orange was settled out of court in 1979. The Veterans Administration now offers Viet Nam veterans treatment for these conditions.

Dioxin is regarded by many as the most toxic substance made by man[82]; it may be as much as 10,000 times more lethal than cyanide [Bellini p.29]. As the Agent Orange research has

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[81]Chloracne, Non- Hodgkin's Lymphoma, Soft tissue Sarcoma, Hodgkin's disease, several respiratory cancers, multiple myeloma, prostate cancer, type II diabetes and Spina Bifida in children of veterans.

[82].. Actually, dioxin is never intentionally manufactured. It is an unavoidable contaminant created during the production of organo-chlorines such as pesticides and wood preservatives, coolants for electric transformers and when trash containing paper or plastic is burned [Colborn p. 133, Fumento p. 98]. Of course, all of these substances are found in industrial wastes and in landfills where the products that used them are disposed. If not properly contained (which is expensive) these substances may leach into local ground water supplies. Scientists at Dow Chemical claim that dioxin is produced when anything is burned at low temperatures so dioxin has been around "since the advent of fire" and can reasonably be considered a "natural" element in the human environment [Fumento p. 99]. As a test of this hypothesis, General Electric scientists examined 2800 year old mummies which should have contained dioxin from ancient wood fires. None was found [Fumento p. 99].

revealed, Dioxin has been linked to many types of cancer. Ralph Nader has claimed that the "evidence is overwhelming that dioxin is carcinogenic in humans" and that three ounces of dioxin could kill more than a million people [quoted in Fumento p. 99]. Seven companies, including Dow Chemical were sued in a class-action suit brought on behalf of 170,000 veterans. The companies, while denying liability agreed to a 180 million dollar pre-trial settlement [De Perna p. 221]. Thus, the link between dioxin and these health problems was never proven. Before the settlement.[83]

At the time of the civil action, the results of animal studies had not been consistent. At very small doses of dioxin has proven very toxic to guinea pigs. Monkeys were quite a bit less sensitive and hamsters much less sensitive than guinea pigs [Fumento p. 101]. Human studies on the toxicity of dioxin are restricted for ethical reasons. One study done on prison volunteers showed that humans are, at least relative to guinea pigs, not very sensitive to dioxin, at least in terms of short-term, immediate symptoms. The men developed chloracne which cleared up in few months. Long term exposures to dioxin in herbicides have been associated with soft-tissue sarcoma (cancer of the connective tissues) and malignant lymphoma among Swedish forestry workers, but the result has not been replicated in subsequent studies of similar populations. A 1989 study of American workers found no significant health effects, at least beyond chloracne, of high levels of dioxin exposure in their occupations. In 1991, The National Institute for Occupational Study and Health reported a small increase in the incidence of cancer of the respiratory system among workers in a herbicide factory and the likelihood of cancer showed a positive dose-response relationship. As these workers had dioxin levels 400 times higher than the average American, at best, the study shows dioxin to be carcinogenic only at very high doses not likely to be encountered outside of occupational situations. Moreover, the method used to control for cigarette smoking, a major confounding variable, has been questioned [Fumento p. 103-106].

The Study of the issue by the NAS in the context of the Agent Orange case, over a decade later, has put the issue to rest - dioxin is a serious carcinogen and causes many other diseases as well.

Just exactly how many people are harmed by exposure to toxic substances is unknown. In the United States, we know that "some 100,000 deaths occur each year as result of exposure to toxic chemicals in the work place [Faber & O'Connor p. 19-20], but we know little about the effects on the general population's exposure through the use of products or from the pollution of the water supply from buried toxic wastes. Consumers eat pesticide residues on their vegetables, spray herbicides on their lawns, and unwittingly consume them in their water and breath them in the air. Compared to occupation exposures, the exposure of the general public may be small and then the cause-effect relationship may be difficult to isolate. As a consequence, little is known

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[83] The attorney's handling the case said they could have "proved" the linkage to the standard of the "preponderance of evidence" in about 2500 cases (1,000 cancer, 1500 birth defects). [De Perna p. 222]. Dioxin was linked to soft-cell sarcoma, a cancer many veterans had developed, but only in animal tests. But, it was never proved that these cancers constituted a true "cluster" given the "extent of intervening variables and routine exposures" since the war [De Perna p. 222].

about the heath effects on humans. However, recent research has substantially broadened the scope of the potential effects of these substances. While they have always been strongly suspected of being carcinogens, they are now also suspected of confusing the endocrine systems of humans causing cancers and birth defects in children.

A study published in the 1996 New England Journal of Medicine has linked pcbs to a number of learning disabilities in children including depressed IQ. The 242 children in the study were eleven years old and had ben followed since birth. The amount of pcbs in their body during gestation was measured from blood samples taken from their umbilical cords. The presence of levels of pcbs varied across children according to how much contaminated fish from Lake Michigan their mother's ate in the ears before they child was born. The higher the fish consumption and pcb load, the smaller the baby at birth, the smaller the head, and the shorter the gestation. From the beginning and through their early lives the contaminated children were deficient in every measure of development. By age four they were "balky and uncooperative," and hyper-reactive to stress. At age eleven, those who had the highest exposure to pcbs (the top 11%) had IQ depression of just over 6 IQ points and were two years behind the others in verbal skills and word comprehension [Rachel's E&H Weekly, 9/29/96].

The Silent Spring

Rachel Carson's 1962 classic environmental work, *The Silent Spring*, was published out of frustration. Carson was frustrated because the avid debate going on among government scientists about the toxic side-effects of the widespread use of pesticides, most notably DDT, on wildlife and humans alike, was being kept secret. Government officials turned a deaf ear to the debate and follow up funding was nonexistent. Although Carson's work documented a "cavalcade of problems attributable to pesticides - from blindness in fish to blood disorders in humans- she could find no magazine or periodical willing to publish her work."[Steingraber, *Living Downstream: An ecologist looks at the environmental causes of cancer,* p.16]. Carson decided to publish her work in book form and the rest, as they say, is history.

It is not my contention that chemical insecticides must never be used. I do contend that we have put poisonous and biologically potent chemicals indiscriminately into the hands of persons largely of wholly ignorant of their potentials for harm. We have subjected enormous numbers of people to contact with these poisons, without their consent and often without their knowledge. If the Bill of Rights contains no guarantee that a citizen shall be secure against lethal poisons distributed either by private individuals or by pubic officials, it is surely only because our forefathers, despite their considerable wisdom and foresight could conceive of no such problem - Rachel Carson, *The Silent Spring*, pp. 12-13]

Carson did more than condemn the use of pesticides. In a speech before the Women's National Press Club "she questioned the cozy relations between scientific societies and for-profit enterprises, such as chemical companies. When a scientific society acknowledges a trade organization as a 'sustaining associate,' Carson asked, whose voice do we hear when that society speaks- that of science or that of industry?[Steingraber, p. 17].

At the time she published the *Silent Spring*, Rachel Carson was already a highly regarded

science author. Her 1951 book, *The Sea Around US,* won the National Book Award for nonfiction and was translated into thirty languages. Yet none of this had prepared her for the fame she would achieve after the *Silent Spring* was published. She realized she could translate this fame into environmental protection and had planned several new projects. Unfortunately, just 18 months after the *Silent Spring* was published she died of breast cancer at the age of fifty-six. Regrettably, these last few months were tarnished only by "a hornets nest of ridicule and invective" directed at her by the chemical industry in the attempt to discredit both *her* and her work. The industry sponsored witch hunt of Rachel Carson that began in 1964 goes on to this day as does the epidemic of breast cancer that takes nearly one million years of women's lives each year[84]. [Steingraber, p. 17]. In the meantime women spend billions on radiation, surgery, and chemotherapy: the so-called slash, burn and poison therapy. These therapies have greatly increased survival rates, that is, they have "cured" many women from this dread disease. Cure, regrettably, is the best our "for profit" society can offer as there is no profit is prevention.

Chemicals and Cancer: The politics of information.

> This is an era of specialists, each of whom sees his own problem and is unaware of or intolerant of the larger frame into which it fits. It is also an era dominated by industry, in which the right to make a dollar at whatever cost is seldom challenged. When the public protests, confronted with some obvious evidence of damaging results of pesticide applications, it is fed little tranquilizing pills of half truth - Rachel Carson, The Silent Spring, p. 13]

Between 1950 and 1991 the incidence of all kinds of cancer increased by 49.3%. Even with the effects on the growth of lung cancer due to cigarette smoking removed from the data, the overall incidence[85] still increased

[84]The average women who dies of breast cancer loses twenty years of her life [Steingraber p. 17].

[85] Incidence is measured as cases per 100,000 in a specific age group. This measure eliminates the upward bias that would be present due to the fact that incidence rises with age. For example, controlling for age, in 1982, 90 out of every 100,000 women in Massachusetts were diagnosed with breast cancer. By 1990, this incidence figure had risen to 112/100,000. Higher incidence rates can reflect a true rise in the number of women contracting breast cancer or simply better detection. For example, many more breast cancers are being found with the use of mammograms. The early detection through mammograms accounts for about 25%-40% of "the recent upsurge" in incidence. Even with allowance for early detection bias, the incidence of breast cancer has been growing steadily at about 1-2% per year since 1940. The increase has been particularly acute among women over 65(40%) and black women (30%). Neither of these groups is "well served" by mammograms.

Incidence is different from death rates. The incidence of childhood cancers has risen by about one-third since 1950 and by 10.2% between 1973 and 1991, but the death rate fell by nearly 50%. "Heroic measures" have reduced mortality rates, but growing incidence means that, over time thousands more children will die from leukemia and brain tumors. Overall, between 1973 and 1991 the incidence of all cancers rose by 20.6% and mortality declined by 2.8%. If lung cancer is added back into the picture overall cancer mortality rose by 6.9%. However, the corner is being turned. Between 1991 and 1995 overall cancer mortality fell by 3% primarily due to the decline in lung cancer deaths. One fourth of all cancer deaths are from lung cancer and 87% of all deaths due to lung cancer

by 35%. No cancers show increasing mortality and declining incidence. Some cancers are decreasing in incidence and mortality e.g. stomach, pancreas, larynx, cervix, and uterus. Some show increasing incidence but, due to more effective treatment, they show declining mortality e.g. ovarian, testicular, colon, bladder and rectal cancers. These gains have been swamped by cancers that are rising in incidence and mortality e.g. cancer of the brain, liver, breast, kidney, prostate, esophagus, skin, bone marrow, and the lymph system. Over the past decade overall breast cancer mortality has fallen by nearly 7%, but it is still higher than it was when Rachel Carson died (1964) and it is still rising among black women [Steingraber p. 42].

	-----ALL RACES-----		----------WHITES----------	
Cancer type	Incidence in 1989	Deaths in 1989	Percent change in incidence, 1950-1989	Percent change in deaths, 1950-1989
stomach	20,000	14,185	-73.5	- 76.0
cervix	13,000	4,487	-76.0	- 73.9
colon/rectum	151,000	57,023	+10.0	-25.6
ovaries	20,000	12,256	+8.2	-0.2
larynx	12,300	3,727	+62.4	-10.1
testicles	5,700	392	+115.0	-66.4
bladder	47,100	10,121	+55.7	-35.6
Hodgkin's	7,400	1,721	+29.2	- 65.5
childhood cancers	6,600	1,768	+9.8	-61.1
leukemia	27,300	18,406	+7.8	- 2.1
lung	155,000	137,013	+263.8	+245.2
skin	27,000	6,161	+321.0	+152.4
breast (female)	142,000	42,836	+52.5	+4.7
prostate	103,000	30,519	+108.8	+14.8
kidney	23,100	9,638	+109.4	+28.0
non-Hodgkin's lymphoma	32,800	18,064	+158.6	+108.7
All types excluding lung	855,000	359,117	+29.9	-19.4
All types	1,010,000	496,130	+44.3	+3.2

Source: Lynn A. Gloeckler Ries and others, editors, CANCER STATISTICS REVIEW 1973-1989 [National Institutes of Health Publication No. 92-2789] (Bethesda, MD: National Cancer Institute, 1992), Table I-3, pg. I.23. NIH says historical data for non-whites are not considered reliable spanning the period 1950-1989 so historical data are only given for whites.

For the most part, there is no widely accepted "scientific" explanation for the uptrend in the incidence and mortality of cancer. One leading researcher, suspects the "substantial worldwide increases in chemical production that have occurred since WWII."[86] This hypothesis, however, "has not been adequately assessed" and needs to be "systematically evaluated." [quoted in Steingraber p. 42-43]. Two senior scientists at the National Cancer Institute lamented that the hypothesis that the rising trend in cancer was being driven the "growing chemicalization of the human economy" was not being examined [Steingraber p. 43]. In 1994, The National Cancer Advisory Board reported to Congress, "that a lack of appreciation for environmental and food source contaminants has frustrated cancer prevention efforts" and it called fora government sponsored "coordinated investigation of industrial chemicals and pesticides as causes of cancer. Despite such information, potential environmental causes of cancer seem "to keeping falling off the cancer screen" [Steingraber p. 43, 45].

One cannot help wonder, if cancer of the penis struck 175,900 men each year, followed in most cases by surgical phallectomy, whether there wouldn't a pained outcry from Congress with an instant and generous outpouring of funds to find causes and promote prevention. Yet in the case of women's most deadly, disfiguring, traumatic and costly cancer, the good old boys who dominate the cancer establishment continue funding work on surgery, chemotherapy and radiation; ways to cut, poison, and burn women in the name of saving them, rather than funding research on way's to maintain women's health through prevention - Peter Montague

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are attributed to smoking cigarettes [Sandra Steingraber, *Living Downstream*, Chapter 3]

[86]The insecticides and herbicides used in the United States after WWII were developed during WWII as part of the Military's Chemical -Biological Warfare program. They were intended to kill or debilitate humans. Their effectiveness on insects was an unintentional discovery. These substances, intended to harm humans were first tested on insects [Carson, *The Silent Spring,* p. 16]

Environmental causation of cancer

Cancer risk, it is now well known, most notably in the case of breast cancer is to some extent determined by genetic factors. Cancer after all, in Sandra Steingraber's words, is "mitosis (cell growth) run amuck"[p. 240]. Since mitosis is controlled by the genes, specifically called oncogenes, one would be surprised were they not implicated in oncogenisis. When these genes get "hyperactive," for one reason or another, cancer is the result [Steingraber, p. 242]. Another set of genes are called "tumor suppressor genes," which, if they do their job, can suppress cell division and prevent cancer from developing from damaged oncogenes [Steingraber, p. 241].

Of course, the chromsomal "alterations" that produce cancer can be either inherited, be the result of mutation, or be acquired. In the latter case, there would have to be an environmental factor involved, e.g. ionizing solar radiation, or some kind of exposure to some kind of carcinogen. The carcinogens in one way or another damage the genes that regulate cell growth.

Hence, even in a carcinogen free environment there will be some cancer. Thus one way to determine the degree to which cancer is "environmental" is to scour the world looking for the place with the lowest cancer rate. If we then compare the "lowest rate" with the higher rates we get some evidence of environmental causation.

Since there are probably carcinogens everywhere we know our observed "lowest" cancer rate will be somewhat higher than the "natural rate." But, on the other hand, we know there may be other genetic factors that protect some groups. For example, skin cancer rates in Africa are far lower than in Arizona because natural selection has provided Africans with more melanin that it gave Norwegians living in Phoenix. These factor will produce some "noise" but it will matter only if the signal happen to be weak, which it most definitively is not.

Based on an analysis of cancer rates in 70 countries, using the framework noted above, The World Health Organization concluded that 80% of cancers in the world have environmental causes [Steingraber, p. 60]. Of course, in addition to exposure to industrial and agricultural carcinogens, environmental causes include cultural factors such as smoking, breast-feeding, sexual practices (Nuns have more breast cancer and less cervical cancer), food choice and preparation (see Bruce Ames), alcohol consumption and so on.

It is worth noting, however, that when people migrate from low cancer countries to high cancer countries, after a generation or two, the group cancer rates converge on that of the new country and vice versa.

Japan has very low cancer rates relative to the US, but the rates have been converging for some time as Japan has "modernized" [Steingraber, p. 62]. Thus, when a Japanese family moves to the US the adult women are unlikely to develop breast cancer. But, in one or two generations, their female children and grandchildren will face the same breast cancer risk as all American women. On the other hand, when English women move to Australia, over a generation or two, the risk of breast cancer will converge on the lower Australian average.

It would appear then that, as ecologist and cancer survivor Sandra Steingraber asserts, "death from cancer is not randomly distributed in the United States," or around the world for that matter [p. 63]. For all cancers, the areas of highest mortality are also the areas where industrial activity is most concentrated: the coastal northeast, the Great Lakes area, and the "cancer alley" along the Mississippi just above New Orleans [p. 63]. There is also a significant relationship

between agricultural use of pesticides and cancer rates in rural America [p. 63]. And, most importantly, Steingraber contends, these saliencies in cancer mortality cannot be explained by differences in access to health care. If health care variance were the main explanatory factor, similar patterns would appear for other important sources of mortality, but they do not [p. 63].

Patterns of cancer mortality by type also suggest environmental causation. Cancer mortality in the American agricultural heartland is primarily from Myeloma, Leukemia and Lymphoma each of which is associated with pesticide exposure [p. 64]. In the South, melanoma, caused by exposure to the sun, is dominant [p.64]. Deaths from breast cancer follow a "north to south gradient"- rates are notably high in the industrialized northeast. However, as industry has shifted south over the past few decades, the breast cancer mortality differential has closed "quickly"[p.64].

Perhaps the most significant aspect of one's environment is where one works. Not surprisingly then, there are some 60 occupations that experience elevated rates of cancer risk [p. 65]. One of the most dangerous occupations in terms of cancer risk is farming. All over the world farmers show "consistently higher rates of mortality from multiple myeloma, melanoma, prostate cancer, non-Hodgkin's lymphoma and brain cancer [p. 65]. Migrant farm workers experience a higher risk of multiple myeloma, and stomach, prostate, and testicular cancer [p. 65].

"Elevated cancer rates are also found among painters, welders, asbestos workers, plastics manufacturers, dye and fabric makers, firefighters, miners, printers, and radiation workers."[Steingraber, p. 65]. Many of the cancers of children are the result of parental occupational exposures to carcinogens. Both brain cancer and leukemia in children are "consistently associated" with parental exposure to paint and petroleum products, solvents and pesticides [Steingraber, p. 65]. Children may be exposed in utero, through breast milk or in the home as residues of the carcinogens fall from the parent's work clothes [p. 65].

Finally, one notes a gender difference in patterns of cancer mortality. While a gender may be genetic or a function of "lifestyle"to some extent (men are at much lower risk of breast cancer and smoke more). But, for any given cancer in the industrialized countries, men tend to have higher rates than women. Researchers have attributed the bulk of the difference to the fact that men historically have had more occupational exposure to chemical carcinogens rather than genetic or lifestyle differences. Unfortunately then, as equal opportunity lead to convergence in the male-female occupational distributions, we can expect some convergence in the pattern of cancer risks [Steingraber, p. 66].

Given the evidence presented above one would expect to find high rates of cancer where in places where industrial chemical carcinogens are concentrated. It is a matter of social concern to know where they are and who lives in the high risk areas.

Several studies have found spiked cancer rates (colon and stomach cancers) in areas near hazardous waste sites [Steingraber, p. 71]. New Jersey, for example, has 112 Superfund sites, and there is a clear pattern of breast cancer risk that decreases as distance from these sites increases. Women near hazardous wastes dumps also suffered relatively high rates of lung, stomach, and bladder cancer [p. 71]. Men living near these sites suffered higher mortality from "cancers of the lung, breast, bladder, esophagus, colon and stomach" [p.71].

Of course, these epidemiological "associations" do not prove the existence of cause and effect relations. Until scientific studies have proven these relationships and have explained the biological mechanisms that generate them there will be legitimate uncertainty as to their validity. At the same time, as Sandra Steingraber warns, one needs to be concerned, "that the uncertainty over details is being used "to call into doubt the fact that profound connections do exist between human health and the environment" [p. 73].

Environmental Justice or where are the toxic wastes dumped - not in my white-middle class back yard.

Robert Bullard's 1978 book, *Dumping in Dixie* was the first to document that the risks of living with toxic wastes was not randomly or fairly distributed across the population. He found that landfills and incinerators across the South were almost exclusively located in poor-black areas. In 1987, the Commission for Racial Justice established by the United Church of Christ conducted a study of the location of toxic waste sites and polluters.

The Commission Study found that

- 40% of all waste disposal was in predominantly black and Hispanic neighborhoods
- 60% of all African-Americans and 50% of Asians and Indians lived in communities with uncontrolled toxic waste sites
- In clean areas minorities were 12% of population - in dirty areas they were 24% - in real dirty areas (two superfund sites) they were 38%.
- 3/4 of Blacks and 50% of Latinos live in LA's dirtiest zip codes . Only 1/3 of whites live there.
- Race not income (class) is the primary determinant of who lives near a toxic waste dump of polluter (smelter, incinerator).
- Race determines likelihood of superfund cleanup as opposed to "capping"
- Race also negatively correlated with size of fines to polluters

The hypothesis that the causes of the epidemic of cancer is related to the "chemicalization of the human economy" is not without critics. The 1980s witnessed a veritable deluge of books and articles published by conservative think-tanks such as the American Enterprise Institute, the Cato Institute, The Center for the Defense of Free Enterprise and numerous industry-funded "institutes" such as the American Council on Science and Health and The American Industrial Health Council.[87] The common theme of this "literature" is an assault

[87]The AHIC is supported by the steel, chemical, pharmaceutical and textile industries. It was formed in 1977 to counter an OSHA initiative that would regulate carcinogens "generically" rather than on an individual basis. The change in procedure was intended to reduce the costs of regulation which now required each substance be considered individually. Labor secretary Ray Marshall likened the existing procedures to "trying to put out a forest fire one tree at a time" [quoted in Proctor p. 124]. AHIC denounced the OSHA plan as too costly to users of chemical products. The program began nonetheless in 1980, but was stopped with the election of Ronald Reagan

on the so-called environmental radicals, their apocalyptic visions, their putative distortions of science (i.e. their "junk science"), and the threats they pose to economic prosperity and even to individual freedom. The backlash strategy was to create doubt regarding the "scientific basis" of the environmentalist program. These right-wing critics allow that at some levels of exposure chemicals are toxic, but those levels are far above current regulatory standards. Furthermore, while perhaps risky, chemicals offer benefits that make the risks "worth it." Moreover, Environmentalists are portrayed as elite, Luddites ("chic-apocalyptic-neoprimitives") with Marxist, totalitarian propensities ("penthouse proletariat"). In short, privileged "zealous malcontents" to which no blue-collar person, or a person who values their job or their freedom should listen [Proctor p. 87]. The right-wing literature dismisses the warnings of environmentalists as "alarmist fantasy" and insists that the human future will be less crowded, less polluted and more ecologically stable" than the present [Shabecoff p. 204] These books imply that environmentalists, like government bureaucrats, often have self-serving agendas and seek only to perpetuate their empires.

For example, Nora Efron,[88] whose book, *The Apocalyptics*, which has been called the "Silent Spring of the counter-revolution," attacks the "cancer 'prevention' establishment" for hyping the cancer risk from substances produced by industry. As they do this "without evidence," that is "the evidence of toxic hazards is ambiguous, inconclusive, or incomplete" they can be little more than ideologues of the "Carsonian religion" promoting their own agendas and interests while scaring the public to death and wasting billions in useless cancer prevention programs [Proctor p. 88-89, Sabecoff p. 223]. Efron includes among the "Apocalyptics" people such as Rachel Carson, Lewis Mumford, Barry Commoner, René Dubos, Paul Ehrlich, any number of Nobel laureate scientists, the staff of the National Cancer Institute, and the scientists in the government regulatory and research agencies [Sabecoff p. 224]. Efron's call is for more research, scientific risk assessment and the rational calculation of benefits and costs.

Views like those of Efron were dominant in the Reagan Administration and surely led to the elimination of and/or delay of the implementation of regulations "which might cut profits" [Proctor p. 125]. Under Reagan, the traditional approach, which assumed that any substance that caused cancer in laboratory animals was a potential threat to humans *at any level of exposure*, was effectively abandoned. Instead, the emphasis shifted to establishing "safe" threshold exposures, an approach not without scientific credibility. Generally, the putative level of safe exposure of most carcinogenic chemicals were increased. The type of evidence of risk was also altered. Under Reagan, rather than using information produced in tests on laboratory animals, the research protocol shifted to epidemiological studies on human populations [Sabecoff p. 224]. As a general principle, under Regan, a potential carcinogen was deemed innocent until proven guilty "with a high degree of certainty" [Sabecoff p. 224, see the section on the Precautionary Principle].

While it is not unreasonable to assume that thresholds may exist, the use of epidemiological evidence to prove a substance dangerous is problematic. Due to the usually small number of observations in sample "clusters" it is very difficult to meet the rigid

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[Proctor p. 124].

[88] Efron, of course, claims to be a "neutral." Yet, her funding sources include the Olin Foundation, infamous for its support of "racist" research, Pepsi-Cola, and William Buckley's, Historical Research Foundation [Proctor p. 89].

requirements of "statistical significance." Indeed, while there have been in many cases very strong indications of a link between a carcinogen and human health problems, there has not been a single case where a a linkage has been verified by epidemiological analysis of cancer clusters. However, reasonable it may appear on its face, many scientists see the Regan program as ideologically motivated. Indeed, one observed called Regan's approach to cancer "supply-side carcinogenesis" [Sabecoff p. 224].

The business community welcomed Reagan's new emphasis on science because it understood that "science, like statistics can....be made to serve the master who pays for it" [Sabecoff p. 225] and the "pockets" of the corporate world are very deep. Yet the Reagan program to weaken environmental laws met stiff bipartisan resistance in Congress. Moreover, despite its regressive attitudes on other social issues, Americans retained a strong preference for environmental protection. A Gallup poll taken I the late 1980s found that three out of four Americans considered themselves to be "environmentalists" [Shabecoff p. 233]. The average American, particularly the average woman, at the grass roots level would not tolerate environmental abuse, most especially that which endangered their children. Even with the full support of the corporations and a Supreme Court stacked with conservative Reagan appointees, Reagan could not vanquish environmentalist politicians such as John Chafee of Rhode Island and Robert Stafford of Vermont, both Republicans who allied with like-minded Democrats, and with solid popular support, held their ground [Shabecoff p. 227, 233].

While there was little regression in the environmental agenda during the Reagan years, it is reasonable to say that it was little advanced. There were some improvements in the Clean Water Act (over Reagan's veto), lead was removed from gasoline, and ironically Reagan's budget cutting mania took the Department of the Interior out of the ecologically destructive dam-building business, but, for the most part, in terms of advancing the cause of environmental protection, "it was eight lost years" [Shabecoff p. 229,230].

Surely, the evidence of the chemical contamination of the world is unassailable. It was so even in Rachel Carson's time. The question remains as to how much damage this contamination is doing to the living things of the world. Our knowledge is far from complete and may never be so, especially with the deliberate obfuscation of industry and the foot-dragging of a government that would simply rather not know, hindering the quest. But as Rachel Carson so eloquently put it, "the obligation to endure gives us the right to know."[Carson, Silent Spring p. 13].

In 2002, the EPA was considering banning the herbicide Atrazine, the most widely used herbicide in the US. Atrazine is used both by commercial farmers and households to rid fields and lawns, respectively, of weeds. The reconsideration is based on a law suit by employees of Syngenta AG (Switzerland), the major producer of Atrazine. The employees contend that they developed prostate cancer as a result of their exposure to Atrazine. Moreover, there is animal research that suggests the substance is harmful. The studies showed that frogs exposed to the substance develop both male and female reproductive organs. The manufacturer contends that the higher incidence of prostate cancer among its employees is not the result of the herbicide, but rather of more careful screening of employees than that for the general population. The company also claims that the animal tests resulted in cancer through pathways that would not be applicable to humans. The studies done by the company generally "discount one by one many of the studies done by the EPA" [John Cushman, New Study Adds to Debate on EPA Rules for

Pesticide(sic),New York Times, 6/02/02)].

Environmental advocates insist that given the number of indications of problems the best avenue to follow is the "precautionary principle" and ban the substance. The substance is banned in Europe [Cushman, New York Times].

Smoke and mirrors

For years, breast cancer research (centered at the National Cancer Institute [NCI] in Bethesda, Maryland) has focused not on prevention but on therapy and treatment --earlier detection, better chemotherapy, better radiation, and better surgery. These approaches have allowed many women to survive the disease(most of them without their breasts) but they have done little or nothing to prevent the scourge. This non-preventive approach has been promoted aggressively by "Breast Cancer Awareness Month," an annual campaign that surfaces every October, sponsored by 17 governmental, professional, and medical organizations, including the National Cancer Institute. Breast Cancer Awareness Month was initiated in 1985 by a British chemical conglomerate called Imperial Chemical Industries (ICI),now known as Zeneca Pharmaceuticals. Breast Cancer Awareness Month is "focused on educating women about early detection of breast cancer." Breast Cancer Awareness Month has promoted the slogan, "Early Detection is Your Best Prevention," but this is nonsense --if your cancer can be detected it's too late to prevent it. Breast Cancer Awareness Month --with all the authority of those 17 sponsoring organizations --consistently diverts attention away from real prevention. According to a recent investigative report on Breast Cancer Awareness Month (BCAM) by Monte Paulsen (DETROIT METRO TIMES, May, 1993), "ICI has been the sole financial sponsor of BCAM since the event's inception. Altogether, the company has spent several million dollars' on the project, according to a spokeswoman. In return, ICI has been allowed to approve -- or veto --every poster, pamphlet, and advertisement BCAM uses." Thus the lack of a prevention message from Breast Cancer Awareness Month has not been accidental, and the 17 sponsoring agencies have adopted and endorsed Imperial Chemical's program and message. Breast Cancer Awareness Month thus reveals an uncomfortably close connection between the chemical industry and the cancer research establishment in the U.S. Imperial Chemical --with revenues of$14 billion --is among the world's largest manufacturers of pesticides, plastics, pharmaceuticals and paper. ICI is also a major polluter. For example, one of its Canadian paint subsidiaries has been held responsible for 30% of all the toxic chemicals dumped into the heavily-polluted St. Lawrence River which separates the U.S. from Canada.

Zenca Phameceuticals also has no interest in cancer prevention. It sells $470 million of Tamoxifen citrate, the best selling cancer drug in the world and operates a chain of cancer treatment centers..- Peter Montague, Rachel's Environment and Health Weekly

Toxic waste

In the 1960s and 1970s Americans were distressed by several eco-horror stories. Times Beach, Missouri became a ghost town after the roads were oiled with a substance that contained dioxin.[89] This situation became, in effect, a spill of hazardous wastes when flood waters spread the dioxin all over the town and contaminated wells. Love Canal,[90] a neighborhood of Niagara

[89] Times Beach was evacuated, but subsequent studies of the population found no evidence of unusual health problems [Fumento p. 136].

Falls New York, was abandoned when 42 million pounds of toxic wastes buried in an unused canal by the Hooker Chemical Company were believed to have caused birth defects in children and chromosome damage in adults.[91] Between 1947 and 1952, the Hooker chemical company has disposed of 21,800 tons of toxic wastes, including several hundred pounds of dioxin, in the canal [De Perna p. 91]. Hooker donated the land to the town so the town could build a school and a playground on it without notifying the town of what was buried there. The school was built and some remaining land was sold to a private real estate developer. Over the next few years about 900 families moved into the area. The public became aware of the problem only when a toxic goo began to leak into basements of the new homes [De Perna p. 93].

In 1953 the land was sold to the Board of Education of Niagra Falls for one dollar. Despite warnings from Hooker of the potential health hazards, the town built a school on the site. It has been suggested that the city, by disturbing the "burial site," was at fault for the subsequent infiltration of the chemicals into the neighborhood. In 1976, residents of the area adjacent to the canal began to complain about chemical odors. Eighty different chemicals including benzene, PCBs, trichloroethylene, and dioxin were found. Since then the total has risen to 248 and now to 444. Soon the Niagra Falls Gazette reported that , based on a "random survey" residents of Love Canal suffered high rates of hearing disorders, rectal bleeding, skin problems, sinus and respiratory ills and headaches. Needless to say the residents of Love Canal were terrified. The EPA fanned the flames when it suggested that the chemical exposures of Love Canal residents may be linked to the higher incidence of chromosome damage observed among them [Fumento p. 117, 119,120].

Another theory asserts the cause of the problem to be a year of unusually heavy rains and snow. As a consequence, the landfill subsided, barrels popped up, and ponds and surface water contaminated. Then oily residues seeped into basements, corroding sump pumps. The neighborhood smelled of noxious chemical odors. These events were surely disturbing in their on right, and surely caused a great deal of anxiety among the residents.

In April 1978, the NY department of health ordered the landfill site fenced in and closed the 99th street school. Two-hundred and forty families were evacuated [De Perna p. 85]. The State purchased 238 houses.

In order to prevent more Love Canals, President Carter initiated the "Superfund program" to clean-up toxic waste sites. When all was said and done some 60 million dollars of state and federal money was spent on the Love Canal problem [Fumento p. 120]. However, the Love Canal site was not cleaned up, it was merely "capped" with a layer of clay to prevent further release of the toxic chemicals underneath.

Amateur epidemiology

Lois Gibbs had observed that her children seemed always sick with one malady or

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[91] 25. A study by the Center for Disease Control found no evidence of unusual incidence of birth defects or child cancer at Love Canal [Bellini p.27]

another. They had rashes, respiratory problems and blood disorders. When the toxic wastes became manifest she surmised that they might have been responsible for her children's illnesses. She became an amateur epidemiologist. She interviewed the other mothers in her neighborhood and discovered that about half of the babies born in the area had suffered one birth defect or another and there seemed to have been an extraordinary number of miscarriages. Nevertheless, anecdotal evidence is not science. Even scientific epidemiological studies are difficult in situations like that of Love Canal.

Epidemiology is based on statistics, and statistics is based on the "law of large numbers." The task of identifying "statistically significant differences" in disease rates between those who lived in Love Canal and those in the surrounding area of Niagara County is very difficult if not impossible due to the small number of cases in the Love Canal area. If statisticians are to have a reasonable confidence in their inferences they must be assured that they have enough cases to warrant trust in the patterns observed. The fact is that even a random process can produce patterns or clusters of outcomes. For example, try flipping a coin a few times. You may get 4 or five consecutive "heads, and infer that the coin is somehow unfair. But, you hypothesize that if you flip enough times, the result will be about 50% heads. If you flip the coin one thousand times and you get 65% heads you will be more comfortable assuming the coin is unfair. Thus, professional epidemiological studies rarely find any evidence of statistically significant differences when the number of cases is small.

Over the following years, professional epidemiological studies have found and unusual incidence of a number of medical problems in the Love Canal children. The studies found Love Canal children suffered from higher rates of developmental problems such as low birth weight, birth defects, learning disabilities, hyperactivity, skin rashes, abdominal pain, chronic illness, stunting and incontinence. Only one death (Jon Kenney died of kidney disease in 1978) has been attributed to the chemical pollution of the local water. A wrongful death case was settled out of court in 1985.

A long-term study of the health of the people of Love Canal began in 1997, and is still in progress (2004). Preliminary result reported in 2002, found no excess mortality from cancer among Love Canal residents, nor was there any evidence of premature mortality for any reason. The study also reports that there seemed to be no differences in premature births (a common cause of low birth weight) among Love Canal women.

Just compensation?

After a 16-year legal battle, the federal government won a $129 million settlement from occidental oil to cover remediation costs incurred at Love Canal. Again, ironically, given that Love Canal is responsible for the Superfund Law, the site was never cleaned up - just capped with clay- the chemicals are still there.

Love Canal has now been declared safe for occupation by the Federal Government. Some 200 families have moved into the area. The abandoned house were sold to the returnees and new settlers for $50,000, some 20% less than market value. Residents of Love Canal have not been compensated for the damage, both physical and psychological they suffered as a consequence of the incident.

Superfund

There are about 36,000 abandoned hazardous waste sites in the US. The General Accounting Office has placed the number somewhat higher - 425,000. Only 1290 sites have been placed on the National Priority list, that is those that will be funded by the Superfund. This list may be eventually expanded to 4500 sites [Cunningham and Saigo, 1997, p. 526]. Of the sites on the current NPL, 75% have led to contaminated groundwater and over half have contaminated surface waters with some of the 444 toxic chemicals buried or stored on them [Cunningham and Saigo, 1997, p. 527].

No one really knows how much it will cost to clean-up all of the Superfund sites but some estimates range from $30 billion to as high as $500 billion to one trillion dollars! Michael Fumento, a critic of superfund, has argued that $30 billion could produce 300 million mammograms that would, by producing early detection, save tens of thousands of poor women from breast cancer. There is no such clear linkage, he claims, between expenditures on Superfund and reduced mortality and morbidity [Fumento p. 133]. Indeed, Environment Magazine claimed that the "benefits of the Superfund clean-up are highly questionable" [quoted in Fumento p. 133]. Yet, the conventional wisdom is that in the absence of any clear evidence of the effects of dioxin, the EPA should err on the side of caution. Indeed, one might ask Mr. Fumento if her would move should he discover the water his children are drinking comes from an aquifer that sits below a superfund site. Fumenteo would also condemn the Superfund because so much was spent on attorney's fees instead of clean-up. But, one must ask whose fault was that?

Ultimately the liability for toxic waste sites falls on insurance companies. In 1993 some insurers estimated that the potential exposure of the industry to be as high as $213 Billion, and amount that threatened to bankrupt the industry that had only $165 in casualty reserves for all hazards. The industry thus began a program of trying to avoid liability through litigation. Basically, they were trying to get the courts to nullify the policies issued to polluters on the grounds that hazardous waste dumps are not natural casualties, they are court mandated casualties that were not covered in the original policy. Thus, of all superfund related expenditures, according to the Rand Institute for Civil Justice, 88% of the $418 million spent on Superfund has been spent on litigation and only 12% on clean-up [Rachel, 10/7/93].

The major polluters like Monsanto have pursued a similar, delaying strategy. Monsanto has blatantly insists that the toxic chemicals (pcbs at 7,400ppm) in 12 dumps on its land (½ mile from its PCB plant) were put there by some one else. As the company has destroyed all of its waste records, the state of Illinois has been unable to prove the wastes belong to Monsanto. Each year, 13 tons of toxic chemical wastes leach into the Mississippi River [Rachel, 10/7/93].

The Precautionary Principle

Some excess capacity may make our lives much easier in the future. This is another insurance policy. Nature gives us land, water, air, plants, animals, nutrients and more. If we use everything that natures gives us, and then nature takes some back we have nowhere else to go - Richard B. Alley, The Two-Mile Time Machine, 2000, p. 188

After testifying to the ecological damage done in Uzbekistan by the Soviet Union, two Uzbecki men asked incredulously, *is there any other state in the world that permits its own population to be poisoned?* Regrettably, the answer is yes, most of the industrialized countries of the world do so. For centuries Anglo-Saxon criminal law held that one is "innocent until proven guilty." Even though chemicals are opt people, this principle was "thoughtlessly" carried over into other areas of law to protect the right of companies to use new chemicals that could not be proved harmful. In *The Silent Spring*, Rachel Carson was quite explicit; such a policy "meant that the public was to act as guinea pigs, testing the suspected carcinogen along with laboratory dogs and rats" [p. 324].

First, do no harm - The Hippocratic Oath

The Thalidomide disaster forced the government to change this policy regarding pharmaceuticals. Horrified by the deformed "thalidomide babies" the Congress passed the Kefauver - Harris Amendment to the Food, Drugs and Cosmetics Act which assumed that new medical products were "guilty until proven innocent." In short, the proponent of any novelty should bear a heavy burden of proving" it harmless [Hardin 1993 p. 300]. This philosophy now informs the National Environmental Policy Act (NEPA) passed in 1969 largely in response to Rachel Carson's, *The Silent Spring.* Yet, little has been done. In 1998, Sandra Steingraber can still correctly label our regulation of toxic chemicals "the dead body approach: wait until damage is proven before action is taken." "It is" she writes, "a system tantamount to running an uncontrolled experiment using human subjects [Steingraber 1998 p. 270].

A classic case of such an experiment is the introduction of tetraethyl lead into gasoline in 1922. The chemical and automobile companies responded to the contention by public health officials that such a move required diligent study to insure it would not harm the public health, with the assertion that there was no "scientific evidence" that widespread harm would result [how could such harm have been documented before the hazard was released?] so they insisted they had the right to proceed. "Basically, the argued, 'until you can line up the dead bodies, we can do whatever we want.'" Lead poisoning of children is now epidemic in our nation's cities due to no small extent to the lead deposited in urban soils consequent to the use of leaded gasoline. Uncounted millions of children over the years have suffered from brain damage and diminished IQ as a result [Pete Montague, Rachel's Environment & Health Weekly #657 July 1, 1999].

In the spirit of ending these barbaric human experiments, a new principle or ethic for guiding human activities toward the prevention of damage to the environment in general and to human health in particular has been gestating during the past 10 years. It is called the "precautionary principle." This principle was articulated by an international group of scientists, government officials, union people and grass-roots environmental activists from the U.S., Canada, Germany, Britain, and Sweden. That met in January of 1998 in Racine, Wisconsin. The statement is as follows:

"The release and use of toxic substances, the exploitation of resources, and physical alterations of the environment have had substantial unintended consequences affecting human health and the environment. Some of these concerns are high rates of learning deficiencies,

asthma, cancer, birth defects and species extinctions, along with global climate change, stratospheric ozone depletion and worldwide contamination with toxic substances and nuclear materials.

"We believe existing environmental regulations and other decisions, particularly those based on risk assessment, have failed to protect adequately human health and the environment--the larger system of which humans are but a part.

"We believe there is compelling evidence that damage to humans and the worldwide environment is of such magnitude an seriousness that new principles for conducting human activities are necessary.

"While we realize that human activities may involve hazards, people must proceed more carefully than has been the case in recent history. Corporations, government entities, organizations, communities, scientists and other individuals must adopt a precautionary approach to all human endeavors.

"Therefore, it is necessary to implement the Precautionary Principle: When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically (emphasis added). In this context the proponent of an activity, rather than the public, should bear the burden of proof.

"The process of applying the Precautionary Principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action." [End of statement.]

Thus, as formulated in Racine, the principle of precautionary action has four parts:

- People have a duty to take anticipatory action to prevent harm
- The burden of proof of harmlessness of a new technology, process, activity, or chemical lies with the proponents, not with the general public.
- Before using a new technology, process or chemical, or starting a new activity,people have an obligation to examine the "full range of alternatives" including the alternative of doing nothing.
- Decisions applying the precautionary principle must be "open, informed, and democratic" and "must include all affected parties."

The precautionary principle is not really new. The essence of the principle is captured in common-sense aphorisms such as "An ounce of prevention is worth a pound of cure," "Better safe than sorry," and "Look before you leap." However, environmental policy in the U.S. and Europe for the past 70 years has been guided by entirely different principles perhaps best reflected in the aphorisms, "Nothing ventured, nothing gained" and, "Let the devil take the hindmost."

One participant characterized the current decision-making approach as How safe is safe? What level of risk is acceptable? How much contamination can a human or ecosystem assimilate without showing any obvious adverse effects?' The approach stemming from the precautionary principle asks a different set of questions: 'How much contamination can be avoided while still maintaining necessary values? What are the alternatives to this product or activity that achieve the desired goal? Does society need this activity in the first place?'" Participants noted further that current policies such as risk assessment and cost-benefit analysis give the benefit of the doubt

to new products and technologies, which may later prove harmful. And when damage occurs, victims and their advocates have the nearly-impossible task of proving that a particular product or activity was responsible.

1) When toxic chemicals enter our bodies --or the bodies of our children --without our informed consent, it is a toxic trespass. Such a trespass is wrong and almost everyone recognizes that it is wrong.

2) A recent study by the Harvard Center for Cancer Prevention concluded that only 2% of cancer deaths are caused by industrial toxins released into the environment. Steingraber points out that, if we accept such an estimate at face value, this 2% represents the painful deaths of nearly 11,000 individuals each year in the U.S. alone --the annual equivalent of wiping out a small city, thirty funerals every day. And these deaths represent a form of homicide. Such homicides are wrong and almost everyone recognizes that they are wrong.

3) We all have a fundamental human right to enjoy our environment free of fear. Those who put toxic chemicals into the environment --whether as wastes or as products --deny us this human right. Almost everyone recognizes that such a denial of human rights is wrong. At the policy level, Wingspread participant ecological economist, Robert Costanza of the University of Maryland, has suggested an "assurance bond" --which he has dubbed the "4P approach to scientific uncertainty." The "4P" stands for "the precautionary polluter pays principle." Using the "4P" approach, before a new technology, process or chemical could be introduced, the worst-case damage would be estimated in dollar terms. Then the proponent of the new activity would be required to post a bond for the full amount before startup. Such "assurance bonds" are common in the construction industry today, to assure that a job will be completed on schedule. A "4P" bond would effectively shift the burden of proof onto the proponent --if harmlessness could be shown as time passed, some or all of the bond would be returned (with interest). A "4P" bond would also give the proponent powerful financial incentives to reduce the worst case damages by, for example, adopting intrinsically less-damaging alternatives. The "4P" bond would also give the proponent a financial incentive to continually examine the effects of the new activity --if damages could be shown to be less than the worst-case estimate, part of the bond could be returned (with interest) but the burden of proof for such a showing would remain with the proponent. It seems unlikely that the precautionary principle will replace the risk assessment approach to environmental protection, regardless of the clear deficiencies in our assessments of risk, in the U.S. any time soon. Opposition from the chemical industry alone would probably be sufficient to prevent that. A number of advisors to the chemical industry have called the precautionary principle unscientific and dangerous. For example, Jack Mongoven of the public relations firm MBD (Mongoven, Biscoe and Duchin in Washington, D.C.), has advised the chemical industry to "mobilize science against the precautionary principle." Mr. Mongoven says the precautionary principle is antagonistic to science, has its origins in instinct and feeling, and most importantly "threatens the entire chemical industry."

True, the precautionary principle does shift the burden of proof for harmlessness onto the producers of toxic chemicals. Most people readily accept such a shift in the case of the pharmaceutical industry, which must show safety and efficacy before marketing a new drug. The

rationale for placing such requirements on the drug corporations was that humans would be directly exposed to drugs, so safety had to be shown and the need for the new drug established. Today we know that all landfills leak, incinerators don't fully destroy toxic chemicals, and humans are therefore exposed to low levels of essentially every industrial chemical released into commercial channels (whether as waste or as product). Therefore, the rationale for U.S. pharmaceuticals policy would logically lead to the conclusion that all industrial chemicals should be treated the same as drugs: the burden of proof of harmlessness (and proof of need) should fall on the producer. To assure that producers have confidence in their own estimates of harmlessness, the worst-case "4P" bond would serve nicely. (The 4P bond simply asks the chemical corporations claiming "no problem" to put their money where their mouths are.) If the producer's estimate of harmlessness turned out to be wrong, the large bond would be forfeited to pay the incurred costs. Those who say they favor market-based solutions to environmental problems should warmly embrace such an efficient and fiscally-responsible precautionary proposal. Yet they do not.

Recently, the Harvard Center for Risk Analysis, a chemical industry think-tank, held a conference to develop strategies to oppose the precautionary principle. The participants openly ridiculed the idea of precaution, as being unscientific and emotional, but could not controvert the basic ethical premise of the precautionary principle. While the chemical and other industries ask in the language of risk analysis "what is the acceptable level of risk" or the "acceptable level of poison" the PP asks that risk be avoided - no substance shall be released until it is proven safe.

Scientists often define "scientific certainty" as "being 95% sure that cause and effect have been correctly identified." It is exceedingly rare for a large group of scientists to be 95% certain about anything, especially about anything as complex as an environmental problem. When you're talking about living systems, great scientific uncertainty is the norm. Even in the case of an ultra-well-studied chemical like dioxin, scientific uncertainty far outweighs firm knowledge of cause and effect.

How is scientific uncertainty currently treated in environmental protection? For 50 years it has been used permissively. It has been used to postpone actions that would protect public health. Because we have allowed scientific uncertainty to postpone controls on dangerous activities, we now have hazardous levels of mercury in most of the nation's fresh-water fish; the Earth's ozone shield has been dangerously depleted; global warming is upon us, with attendant droughts, fires, floods, hurricanes, tornadoes and typhoons; the ocean's major fisheries are in serious decline; the normal sex ratio of male-to-female babies has been changed in numerous industrialized countries, and human sperm counts have declined 50% in 50 years; immune system disorders like asthma and diabetes are steeply rising; many of the world's coral reefs are dying; cancers of the brain, the lymph system, the blood system and the testicles are increasing; cancer in children is escalating; many species have gone extinct.... This list of contemporary calamities could be readily extended. Pete Montague- Rachel's Environmental & Health Weekly #657 July 1, 1999

"The United States is already in some cases under obligation to operate by the precautionary principle. The federal government signed and ratified the Rio Declaration from the 1992 United Nations Conference on Environment and Development. The Rio Declaration says, "In order to protect the environment, the precautionary approach shall be widely applied by States [meaning nations--P.M.] according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing

cost-effective measures to prevent environmental degradation."

The precautionary principle is now embedded in numerous international treaties and conventions: the Second North Sea Declaration; the Bergen Declaration on Sustainable Development; the Ministerial Declaration of the Second World Climate Conference; the Maastricht Treaty on the European Union; the Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes; and others [Pete Montague- Rachel's Environmental & Health Weekly #657 July 1, 1999].

Risk Assessment

The key to comprehending this issue is the question as to whether it can be determined a priori just what the risks of a certain action might be. The methodology that attempts top answer this question is called risk assessment.

[The following is adapted from Pete Montague Rachel's Environmental and Health Weekly #652 May 27, 1999].

Risk assessment is a decision-making technique that first came into use during the presidency of Jimmy Carter, who was trained as a nuclear engineer. At its best, risk assessment is an honest attempt to find a rational basis for decisions, by analyzing the available scientific evidence. In theory it is still an attractive ideal -- to make rational decisions based on scientific evidence -- because in principle it should allow diverse parties to agree on what needs to be done. However, 20 years of actual practice have badly tarnished the ideal of risk assessment and have sullied the reputation of many a risk assessor.

History of Risk Assessment

During the late 1960s it slowly became clear that many modern technologies had far surpassed human understanding, giving rise to byproducts that were dangerous, long-lived, and completely unanticipated. A book-length report issued by the White House in 1965 began with a letter signed by President Lyndon Johnson, who said, "Ours is a nation of affluence. But the technology that has permitted our affluence spews out vast quantities of wastes and spent products that pollute our air, poison our waters, and even impair our ability to feed ourselves." The 1965 White House report identified numerous major sources of environmental contamination: municipal and industrial sewage, animal wastes, municipal solid wastes, mining wastes, and "unintentional releases," which included automobile exhausts, smoke stack emissions, pesticidal mists, and agricultural chemicals draining into waterways, among others. The main report contained "subpanel reports" on soil contamination, the potential for global warming by carbon dioxide, the effects of chlorinating wastes, the health effects of environmental pollution, and "the effects of pollutants on organisms other than man."

In 1969, the U.S. Secretary of Health, Education and Welfare issued another book-length report on "Pesticides and Their Relationship to Environmental Health." The report said, "Recent evidence indicates our need to be concerned about the unintentional effects of pesticides on various life forms within the environment and on human health. It is becoming increasingly

apparent that the benefits of using pesticides must be considered in the context of the present and potential risks of pesticide usage. Sound judgments must be made."

Therefore by the mid-1970s it was obvious even to journalists and politicians that industrial technology had a massive dark side. Technical mastery of natural forces was leading not to safety and well being but to a careless and accelerating dispersal of dangerous poisons into the biosphere with consequences impossible to predict. During the 1970s, in response to a decade of disturbing reports and revelations, a vast "environmental movement" developed, made up of citizens concerned about one place or another -- their dinner table, the playground in their neighborhood, the river running through their town (often the source of their drinking water). They demanded reforms. Congress reacted by writing laws the size of a telephone book and by creating new agencies and departments to issue enforceable regulations.

As all the early official reports make clear, in those days environmental contamination was viewed through the twin lenses of engineering and traditional toxicology. Traditional toxicology maintains that "the dose makes the poison" -- meaning that everything is poisonous at a high enough dose, and you can prevent poisoning by giving a low enough dose. The engineer seeks to develop a numerical formula that will give the desired result time after time. Blended together, these views gave rise to the idea that the nation merely needed to set numerical "standards" for the discharge of industrial poisons into the environment. The world's capacity to absorb toxicants would be discovered by scientific analysis, toxicologists would determine the safe dose, and engineers would fine tune the nation's industrial apparatus to deliver just that dose and no more. At least that was the theory.

Unfortunately, there was one key element missing from this prescription: pollution pays handsomely. In the short run, corporations that dump their toxic wastes into a river, or bury them in the ground, make much more money than corporations that sequester and detoxify their wastes at great expense. Therefore, a political struggle of enormous proportions ensued. On one side, the petrochemical giants (such as Dow, DuPont, and Monsanto) were by then producing an array of profitable new products -- polymers, plastics, pesticides. On the other side, an alarmed citizenry demanded safety. This got translated into "safe doses."

In response to the new laws and regulations, governments at all levels geared up to make "sound judgments" inside this political pressure cooker. Under these circumstances, "risk assessment" seemed like a way to rationalize government decision-making, instead of allowing bureaucrats to make arbitrary choices: gather the necessary data, ask a group of impartial experts to interpret it, and render a sound judgment. What could be more reasonable?

Unfortunately, it did not work out. In the first place, as we shall see, the necessary data are not available, even today. In the second place, the traditional toxicological assumptions did not hold up under scrutiny. For many poisons, there is no safe dose. And finally, impartial experts are almost never impartial. Someone is paying their hefty fee and that someone often gets the benefit of the doubt when it comes time to interpret whatever data is available. Experts can be bought, it turns out.

In 1995, after risk assessment had been refined for 20 years, three well-known and well-respected risk assessors working for the California Department of Environmental Protection -- Anna Fan, Robert Howd, and Brian Davis -- published a detailed summary of the status of risk assessment.[3] In it, they pointed out:

** There is no agreement on which tests to use to determine whether someone's immune system has been damaged;

** There is no agreement on which tests should be used to assess damage to the nervous system;

** There is no agreement -- and there may never be -- on ways to test for genetic damage.

Without agreement on test methods, people cannot agree on which data to include in a risk assessment. Under these circumstances, different risk assessors will select the data that they believe is relevant and they will usually reach different conclusions --often VASTLY different conclusions.

Furthermore Fan, Howd and Davis point out that

** Genetic damage is a non-threshold event. That is, any amount of a gene-damaging substance can cause damage. Only zero is safe. If such damage occurs in a germ cell, it may be inherited by successive generations.

** Damage to the reproductive system is a non-threshold event. Any exposure to a reproductive toxin may cause damage. Furthermore, a single exposure may have lifelong effects. The only safe dose is zero.

** Likewise, damage to the developmental system is a non-threshold event. A single exposure by an effective toxin may cause damage and such an exposure may have lifelong effects.
Only zero is safe.

** Cancer is a non-threshold event. Any exposure to certain carcinogens may initiate a sequence that results in cancer. The only safe exposure is zero.

There are other problems with risk assessments:

** Science has no way to analyze the effects of multiple exposures, and almost all modern humans are routinely subjected to multiple exposures: pesticides; automobile exhaust; dioxins in meat, fish and dairy products; prescription drugs; tobacco smoke; food additives; ultraviolet sunlight passing through the earth's damaged ozone shield; and so on. Determining the cumulative effect of these insults is a scientific impossibility, so most risk assessors simply exclude these inconvenient realities. Hence, the resulting risk assessment is seriously flawed.

** According to the U.S. National Academy of Sciences (NAS), which in 1983 published the official formula for conducting a risk assessment, risk assessments are supposed to take into
account the special characteristics of the population at risk:

Are they obese? Is their diet adequate? Do they suffer from chronic disorders like asthma, diabetes, or arthritis? Are they very young or very old? Are they pregnant? Do they eat unusual quantities of contaminated foods, such as cheese or fish? Most risk assessors simply ignore this NAS requirement for examining the characteristics of a population.

** Risk assessment, it is now clear, promises what it cannot deliver, and so is misleading at best and fraudulent at worst. It pretends to provide a rational assessment of "risk" or "safety" but it can do no such thing because the required data are simply not available, nor are standardized methods of interpretation. Science, as a way of knowing, has strict limits and risk assessment encompasses a set of problems too complex for science to solve. As Fan, Howd and Davis acknowledge, risk assessment is not a science, it is an art, combining data gathered by scientific methods with a large dose of judgment. Judgment is not reproducible from laboratory to laboratory so different risk assessors reach different conclusions, often based on who's paying.

** Risk assessment is inherently an undemocratic process because most people cannot understand the data, the calculations, or the basis for the risk assessor's judgment.

Now after 20 years, the public is catching on, that risk assessment has been a failure and in many cases a scam. Rather than allowing citizens to reach agreement on what's best, it has provided a patina of "scientific objectivity" that powerful corporations have used to justify continued contamination of the environment. With a few rare exceptions (sulfur dioxide emissions, for example) dangerous discharges have increased geometrically during the period when risk assessment has been the dominant mode of decision-making. It is now obvious to most people that risk assessment is a key part of the problem, not an important part of any solution.

In place of risk assessment, a new paradigm is ripening: the principle of precautionary action. The precautionary principle acknowledges that we are ignorant about many important aspects of the environment and human health. It acknowledges scientific uncertainty and guides our actions in response to it. The precautionary principle says, "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof."

[end Rachel]

How could intelligent beings seek to control a few unwanted species by a method that contaminated the entire environment and brought the threat of disease and death even to their own kind. Yet this is precisely what we have done. We have done it, moreover, for reasons that collapse the moment we examine them. We are told that the enormous and expanding use of pesticides is necessary to maintain farm production. Yet is our problem not one of over production? Our farms, despite measures to remove acreage from production and to pay farmers not to produce, have yielded such a staggering excess of crops that the American taxpayer in 1962 is paying out more than one billion dollars a year as the carrying cost of the surplus food program. Rachel Carson, The Silent Spring, p. 9

Agricultural price supports were established in the 1930s as part of the New Deal. They

put a floor on agricultural prices to protect the income of small family farmers. Farm incomes were prone downward as chronic overproduction of agricultural goods drove down agricultural prices (agrification). Ironically, the soil bank provisions (take land out of production in exchange for subsidy) of the subsidy program encouraged farmers to use new technologies, most notably pesticides and herbicides, to improve productivity on their remaining acreage.

The price support program led to a surplus of agricultural products which were costly to store and much of it rotted or was eaten by rodents and other insects. Many scientists believe the rise in the incidence of cancer among farmers and agricultural workers is related to the use herbicides and pesticides. The central agricultural region of the US has elevated rates of both leukemia and lymphoma. As an occupational group farmers suffer from elevated rates of several cancers including multiple myeloma[92], brain cancer, non-Hodgkin's lymphoma and prostate cancer. Migrant farm workers also endure exceptionally high rates of myeloma, and cancer of the stomach, prostate, and testicles [Steingraber p. 65].

Bruce Ames has quipped that if one wants to avoid cancer, stop smoking and "eat your veggies." Well farmers have a low prevalence of smoking and they eat prodigious amounts of vegetables and are generally in very good physical condition. They have very low rates of heart disease and most cancers, yet they suffer from abnormally high rates of the select cancer mentioned above. The fact that migrant farm workers have the same problem strongly suggests an occupational exposure herbicides and pesticides. Moreover, the is a very close relationship between the types of cancers farmers get and those that afflict people with suppressed immune systems. The etiology of these cancers then may be the immuno-suppresive effects of the chemicals to which farmers are exposed. This linkage has been documented in animal studies, but the number of human studies is negligible [Rachel E&H weekly 4/21/99].

One potato, two potato, three potato, cancer

New York Times Journalist Michael Pollan asked a potato farmer to explain a "season's regimen" of chemical agriculture. It typically begins early in the spring with a soil fumigant; to control nematodes (worms), many potato farmers douse their fields with a chemical toxic enough to kill every trace of microbial life in the soil. Then, at planting, a systemic insecticide (like Thimet) is applied to the soil; this will be absorbed by the young seedlings and, for several weeks, will kill any insect that eats it leaves. After planting, [the farmer] puts down a n herbicide- Sencor or Eptam- to "clean" his field of all weeds. When the potato seedlings are six inches tall, and herbicide is sprayed a second time .[From then on pesticides and herbicides are mixed into the irrigation water] potatoes may receive ten applications during the growing season. As the plants grow and the leaves from the plants get closer to one another, a fungicide -Bravo- is sprayed on them to prevent late blight [every Irish person knows what this is]. Before the crop is in it will be sprayed with Bravo, at least eight times.

Twice each summer the crop is "dusted" by Plane to control aphids. Aphids are harmless but they carry a virus that causes "net necrosis" or brown spots. These spots are a cosmetic

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[92]Cancer of the cells inside the bone marrow. Lymphoma is cancer of the lymph tissue. Both of these cancers in humans are linked to pesticide and herbicides. Dogs suffer a high incidence of lymphomas as a consequence of the use of lawn and garden weed killers. [Steingraber pp. 50-51]

problem to major buyers like Mc Donald's who believe their customers do not want brown spots on their Mc Fries. Mc Donald's customers probably would not want their potatoes sprayed with Monitor, a highly toxic organo-phosphate, either. The farmer reports that Monitor is so toxic he will not go near a field sprayed with it for a week for fear of suffering the neurological damage the chemical is known to produce.

The farmer then revealed to the journalist that he grows potatoes for his own consumption in a separate field near his house. He grows them with out chemicals. "I am not sure I should be saying this" but, he revealed, he won't eat the field potatoes he sells to Mc Donald's because he is certain they are "full of systemics" [Michael Pollan, *New York Times Magazine*, Oct 25, 1998]

Food for Thought [from Rachel's Environmental waste News- 8/22/90

"Negligible Risk or Premeditated Murder?"

The 5th amendment to the Constitution of the United States says, "No person shall be... deprived of life, liberty or property without due process of law." Before the state can execute you, you are supposed to have your day in court, to be judged for your crimes (if any) by a jury of your peers. An execution without due process is a murder. Despite these important protections in our Constitution, murder of innocent Americans is slowly but surely becoming acceptable because of the increasing use of a technique called "risk assessment."

Risk assessment had its origins in the U.S. Food and Drug Administration's (FDA) 1954 decision to abandon the fight to keep pesticidal poisons out of the American food supply. Instead, FDA decided in 1954 to allow (and thus legitimize) certain amounts of poisons in our food. Initially these amounts were called "safe" but as knowledge grew, scientists came to realize that, at least in the case of cancer-causing poisons, someone, somewhere would be harmed if any amount appeared in the nation's food supply. After that realization, "acceptable" amounts were set on the basis of predictions of how many people would be killed. Usually the official goal was to kill no more than one-in-a-million people, though sometimes one in-a-hundred-thousand is deemed acceptable. This technique is now called "risk assessment," and today it is so widely practiced that some people consider it the only possible way to think about such matters, which of course isn't true. Now there are individuals (indeed, whole companies) who do nothing but write "risk assessments" for money; sometimes they work for polluters, sometimes they work for governments, but always they are helping establish how many people will (and, by implication, should) die. Our government now routinely issues licenses (called permits) that allow people to kill other people by putting poisons into our common air and water supplies, and these licenses are based on risk assessments.

The National Academy of Sciences calculates that pesticides are responsible for 2.1% of all U.S. cancer deaths each year; there were 461,520 cancer deaths in the U.S. in 1985; 2.1% of this is 9692 deaths. So government decisions to license pesticides over the last few decades have killed roughly 10,000 Americans each year, according to official estimates. Since there are 245 million Americans, we can calculate that pesticides kill (by giving cancer to) 40 out of every million citizens each year. (You see, the one-in-a-million decisions accumulate as each new one-in-a-million risk is added to the environment. A typical risk assessment does not consider these cumulative impacts of many individual decisions.)

Why do we let our government issue licenses to kill 10,000 citizens each year? We let it happen because the victims die anonymously. They are faceless. We don't know exactly who they are. But what if the names and addresses of the victims were known? If the names of the victims were known, no one would dispute that this is murder. And, "Why should it matter that contemporary 'negligible risk' victims are known only in number and not by name? We do not excuse the killer who shoots into a large crowd of strangers because he doesn't know his victims' names and he kills only a few people or even just one. Why, then, do we tolerate those who spray the crowd with poisons rather than bullets? Is it not still murder? The corpses lie just as dead." [Paul Merrell and Carol Van Strum, *Journal of Pesticide Reform,* 1990, pp. 20-22.]
We allow our regulatory officials to get away with killing large numbers of us because we accept their rhetoric in which they claim not to kill us, but only to impose "risks" on us. And because we accept many risks each day (such as driving our car), they argue we should accept new, chemical risks without complaint. If we accept the substantial risk of driving an automobile, how can we logically object to a tiny (one-in-a-million) added risk from chemical contamination of our food or water?

"A better question is, why should we be so naive? These offenders do not impose 'risks' upon a crowd; they deliberately execute individual human beings in the name of profit," Merrell and Van Strum argue. They actually kill real people by their decisions, not merely impose abstract "risk." And it is important to note that the informed consent of the victims is not obtained.

A few years ago, nationwide fear and outrage erupted when a small number of people died after a few Tylenol bottles were spiked with cyanide. Courts have declared that it is murder for a wife to kill her husband by lacing his chili with parathion (a pesticide), so how can we excuse those who authorize the poisoning of the entire nation's food supply? Is it sufficient justification for murder that only a few will die? If so, how can we justify punishing the Tylenol killer or the wife who murders only one husband?

We need to recognize risk assessment (for pesticides and other hazardous chemicals) for what it is: evidence of premeditated murder. It documents the intent of regulators and polluters to sacrifice individual lives on the altar of profit. The person who writes the risk assessment is an accessory to a felony. The concept of 'negligible risk' is tolerated only because of the anonymity of its intended victims. If our science improved and we could publish the names and addresses of intended victims in the newspaper, risk assessment would immediately be recognized as murder and would cease, you can be sure.

Without dead bodies, it may be impossible to prosecute decision-makers and those who conduct risk assessments, but it still may be possible to prosecute them for conspiracy to commit murder, and for attempted murder, both of which are felonies. Such prosecutions will succeed when this 'negligible' form of murder ceases to be acceptable to prosecutors and to the public. In the meantime, citizens can speak out, reject risk assessment, and call it what it is: premeditated murder of innocent citizens.

Endocrine Disrupters.

In 1962, her book, *The Silent Spring*, Rachel Carson condemned the use of a pesticide known as DDT. Carson claimed the highly effective pesticide was causing reproductive problems

for many species of birds, thus the absence of bird calls by the spring. Of course, the implication was that if DDT was dangerous for birds it was probably dangerous for humans. DDT works on the nervous system of insects and animals. It is also rated by the EPA as a "probable carcinogen."[93] DDT has potentially pernicious effects because it accumulates in human fat[94]. The danger was particularly great for infants as DDT is passed to them through breast milk. Small exposures may not be harmful but over time the substance accumulates in fat and may be dangerous in such concentrations. DDT has proven very toxic in animal studies, but as Carson warned "we have no previous experience to guide us" as to its effect on humans. Nevertheless, DDT was banned in the United States in 1973.

The banning of DDT was of great economic consequence because it had been very effective in controlling crop-eating and disease spreading insects, most especially the mosquitoes that spread malaria and yellow fever. In India alone, Malaria cases were reduced by some 70 million per year and crop yields were doubled in the decade following the application of DDT. Eventually, as DDT killed the natural predators of insects and the latter developed DDT resistant strains its effectiveness was diminished.

In Nicaragua, for example, DDT was heavily used since the 1950s. In the cotton production areas, the areas of heaviest use, women's breast-milk contained 45 times the safe level of DDT. The average Nicaraguan had body fat deposits of DDT that were 16 times than the world average. Yet DDT had controlled crop damage and malaria. Yet by 1960s crop yields began to fall and insects developed resistance to DDT. And, between 1968 and 1970 the number of malaria cases increased four-fold [Bellini p. 185-186]. Following the Sandinista revolution, Nicaragua returned to pest control using natural methods.

The scientific view of cancer clusters

Since the publication of *The Silent Spring*, people have become concerned about the potentially toxic effects of "man-made chemicals" should they enter the human body. Indeed, part of the success of the book was a consequence of the Thalidomide[95] disaster that broke just

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[93]20. The EPA classifies a substance as a probable carcinogen when there is "sufficient" evidence from animal studies, but "limited" evidence from studies on humans [Harte et al p. 32].

[94] 21.DDT and PCBs are concentrated as we move up the food chain. Predators at the top of the food chain can have very high concentrations of these chemicals. Indigenous peoples in the Arctic region are predators at the top of the food chain. The breast milk of indigenous women contains seven times more PCB than normal. Arctic polar bears have very high concentrations of both PCB and DDT [Colborn p. 85].

[95]Thalidomide was a anti-nausea drug administered to pregnant to help with morning sickness that caused severe birth defects in children. Children were born blind, deaf, autistic or epileptic. Many children were born with phocomlia, that is, they looked like seals. They had flipper-like hands, but no limbs. Some 8000 children around the world were deformed and damaged by the drug. The Silent Spring was hence received by a public that was acutely

before the book was published. A rural Michigan town by the name of Swartz Creek became a "latter-day leper colony" when it was discovered that a nearby, bankrupt incinerator company had left behind millions of gallons of toxic wastes. No one was sick, but, as one resident put it, the fear of exposure was so intense that no one would visit, we could not sell our homes and "my sister-in-law won't take gifts of my raspberry jam anymore" [quoted in Bellini p. 27].

In 1993 530,000 people died from some form of cancer. Nearly one-fourth of the years lost to premature death can be attributed to cancer. In part because of the *Silent Spring*, people have come to believe that synthetic chemicals are a major cause of cancer. Man-made chemicals are pervasive in modern life. Humans are exposed to these chemicals at work, in the air they breath, the water they drink, and the food they eat, but the fact is we know very little, in terms of direct scientific evidence about how synthetic chemicals effect the human body. Most of the chemicals considered to be "carcinogenic" have been so defined as a consequence of experiments on rats. Outside of high level exposures in occupational situations, the epidemiological evidence connecting cancer with low-level exposure to synthetic chemicals is virtually nonexistent. While occupational exposures occur within a clear and fixed boundary where there is a direct and obvious link to the substance, the exposures of ordinary citizens are more difficult to link to waste sites and to separate from other potential sources of contamination. For example, in Rutherford New Jersey a "cluster" of Hodgkin's disease and leukemia appeared in 1980. The epidemiological investigators found evidence of low concentrations of several carcinogenic substances in the Rutherford environment, but they concluded that "given the present state of knowledge about the etiology of Hodgkin's disease and leukemia, and the effects of low-level exposure to carcinogens, it is impossible to link the presence of the substances to the cluster" [quoted in De Perna p. 179]. In the twenty years between 1963 and 1983 the Center for Disease Control conducted studies of 101 clusters of various types of cancer with finding a cause in a single case [De Perna p. 30].

The Cancer Myth?

Bruce Ames and others have been pushing the argument that there are no increases in cancer rates. They assert that the evidence we have finds that cancer is caused primarily by human behaviors: smoking, poor diets (too much red meat, to few fruits and vegetables), the consumption of alcohol, sun exposure, chronic infections and inflammations such as those caused by Hepatitis B and C viruses and schistosomiasis. Even "natural" body processes such as the functioning of the immune system, metabolism, and hormones, especially estrogen, are implicated in the etiology of various kinds of cancers [Ames & Gold].

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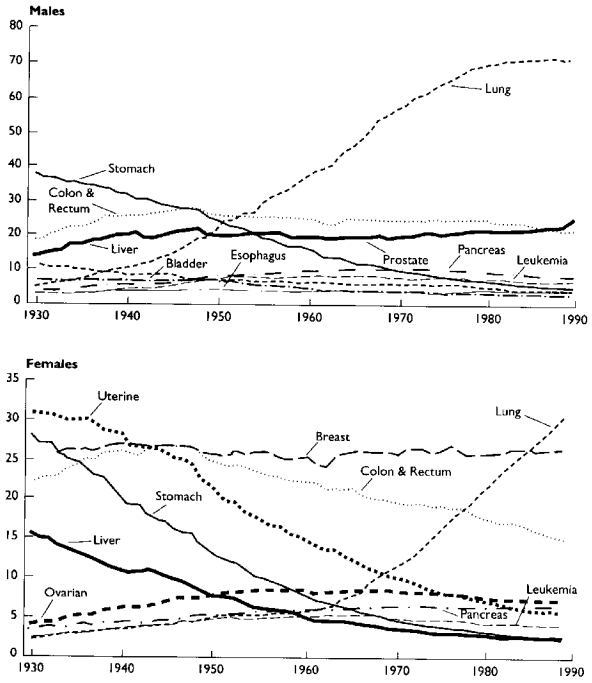
aware of the dangers of man-made chemicals [Colborn p. 50]

Cancer deaths have been rising for the past 50 years, they contend, primarily as a consequence of the explosion of lung cancer which is clearly related to smoking. When mortality due to lung cancer is removed from the data, cancer mortality has actually declined some 14% since 1950 [Ames & Gold p. 146]. Thus, the commonly held view that "there is an epidemic of death from cancer is a myth" (excepting tobacco related deaths from lung cancer) [Ames & Gold p.146]. In the case of toxic wastes, especially, it became almost axiomatic that the effect on humans of these wastes was to cause some form of cancer. Cancer of the lungs (one-third of all cancer deaths)[96], breast, colon and stomach account for about 50% of all cancer. There is some evidence which suggests that these cancers, rather than being genetically determined, are related to dietary and behavior factors and therefore are avoidable. While other factors may contribute, lung cancer is clearly caused by smoking. Less is known about breast cancer except that it seems to be related to fat consumption and perhaps to estrogen exposure. Colon cancer is correlated with meat consumption. These correlations are not proof of causation as much as the fact that cancer is not genetic in origin. This inference is reinforced by the observation that immigrants tend to develop cancer rates similar to those of the indigenous population [Peto p. 531]. While there is no conclusive evidence of the exact nature of the changes required, one researcher has concluded that on the 'basis of the present evidence a switch in developed countries towards a diet lower in animal products, particularly fat, and higher in plant products, particularly fiber, might be prudent" [Peto p. 540].

FIGURE 5-1 Cancer Death Rates by Site, 1930–1990



Note: Rates are per 100,000 and are age adjusted to the 1970 U.S. census population.

Source: American Cancer Society, *Cancer Facts and Figures* (Atlanta: ACS, 1994).

The "diet is the cause of cancer school" led by Dr. Bruce Ames, a scientist at UC Berkeley must contend with the question of the concentrations of cancer incidence in heavily industrialized parts of the United States. For example, a study done by Greenpeace found a higher cancer death rate in counties bordering the Mississippi River which has been characterized as a "chemical sewer" [Environmental Research Foundation, 2/13/1990, Rachel's Hazardous Waste News]. Moreover, the incidence rate rises as one move down the river, maxing out in the "cancer alley" between

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[96]. In addition to the 140,000 lung cancer deaths in 1984, tobacco use also kills by causing other respiratory diseases and heart disease. In both America and England tobacco use accounts for about 15% of all deaths (U.S. 300,00 per year, U.K. 100,000 per year). About one-fourth of regular tobacco users die prematurely as a consequence of tobacco use. The average smoker loses about 10-15 years of life expectancy [Peto p. 536].

Baton Rouge and New Orleans where 136 chemical plants dump into the river.

A study of the State of New Jersey found 23 cancer clusters 3/4 of which were in the heavily industrialized northern part of the state. 2/3 of these communities had elevated death rates in at least five different cancers [Environmental Research Foundation, 2/13/1990, Rachel's Hazardous Waste News]. Even more striking was the finding of elevated cancer risk according to the density of toxic waste dumps [per 100 square miles]. The incidence of 12 cancers was positively correlated with the density of toxic waste dumps and negatively correlated with income. It appears that being poor is a good indicator of the likelihood one lives near a toxic waste dump and thus, the likelihood one will die of cancer [Environmental Research Foundation, 2/13/1990, Rachel's Hazardous Waste News].

The fact is, of course, that there have been increases in certain cancers, both in incidence and death rates. According to data published by the National Institute for Health, between 1950 and 1989 the incidence of breast cancer has increased by over 50% and the death rate by 5%. The rate has continued to increase in the 1990s. Prostate and kidney cancer incidence are both up by over 100% and death rates are 15% and 28% higher. In the case of non-hodgkins lymphoma the death rate is up 100% and incidence up 158%. The incidence of at least five other cancers is also up from 10% to 115%, but fortunately the death rates have fallen due to improvements in treatment. Overall, and excluding lung cancer, cancer incidence is up about 30% and death rates are down by 20%.

How then can Ames & Gold claim that the "epidemic" of cancer is a myth. Even a casual look at their paper gives the answer. Ames and gold show graphs of data published by the American Cancer Society that show clear down trends in most cancers, level trends in some, and a sharp upward trend in lung cancer only. *But, these graphs are of death rates only*. Apparently the rising incidence of breast cancer requires hundreds of thousands of women to be "slashed, burned and poisoned each year" does not constitute an "epidemic" unless more women are also dying. Their argument is at best ingenuous, but is actually a manipulative slight of hand that might catch the unwary, or the die-hard right-wing anti-environmentalist looking only for confirmation of his prejudices. Ames & Gold make no qualification, but they clearly had to understand the implication of this argument.

Bruce Ames - Digression

Bruce Ames, a nationally prominent professor of biochemistry at the University of California at Berkeley, is an expert on the effects of natural and synthetic substances on cancer. In the 1970s, he was a hero to environmentalists. He invented the Ames Test, which allows scientists to test chemicals to see whether cause cancer in humans. His research and testimony led to bans several synthetic chemicals, including Tris, the flame-retardant used in children's pajamas. Since then he has changed his position, and is now a thorn in the side of those who would ban synthetic chemicals. In 1990, he spoke out against California's Proposition 128, which would have banned many pesticides, and he has been highly critical of the ban on Alar. Bruce Ames is not an industry apologist - all of his research is government funded, he accepts no money from industry.

Bruce Ames claims he has read a great deal of economics in the attempt to gain wisdom in his old age. He has been particularly influenced by conservative economists such as F.A. Hayek and Milton Friedman and has labeled himself a "crypto-libertarian." While claiming he is

not a “fanatic” he does hold the basic libertarian ideal “that we should give people the maximum choice possible and let them pay for their mistakes.” Thus, Ames opposes government regulation as a matter of principle. As a libertarian Ames is predisposed to consider any government regulation inefficient if not incompetent. As for the particular case of environmental regulation Ames claims, "we're shooting ourselves in the foot” to “regulate trivia... at the expense of over 2 percent of the G.N.P...”

In addition to the libertarian social philosophy he picked by reading right-wing economists, Ames has also developed an appreciation of the economic concept of opportunity cost. He says, he “likes the way economists think about trade-offs and optimizing.” Appling these principles to his own areas of expertise, he notes that, “if we are spending $125 billion a year on EPA regulation, and it's not effective, that kills people, because it diverts resources from important things and it takes money that could be used for starting new companies and generating wealth and generating money for science.” Ames believes that there is an optimum level of pollution, one where the cost of pollution abatement is matched by benefits. He cannot comprehend environmentalists who “want [absolutely] no pollution.

Ames does not share the “apocalyptic vision of the future of our planet” that is proffered by environmentalists because, he claims it is based on “weak or bad science.” Indeed, Ames’ view of the future is very optimistic:

> The reality is that the future of the planet has never been brighter. With the bankruptcy of communism, the world is hopefully on the path to democracy, free markets and greater prosperity. Science and technology develop in a free society, and free markets bring wealth, which is associated with both better health and lower birth rates. Scientific advances and free markets can also lead to technologies that minimize pollution for the lowest cost. A market for pollution rights is desirable-polluting shouldn't be free-and is much more effective than a bureaucratic monopoly. In my scenario for the future, I would like to see environmentalism based on scientific fact, directed at solving real problems rather than phantoms

Ames recognizes that in large doses as in cases of occupational exposures synthetic chemicals can do harm. One the other hand he is quite skeptical about the danger to humans of small exposures to these substances. Ames, who was a pioneer in developing was of testing for the carcinogenic effects of these substances in experiments on rats, now proclaims such testing is producing misleading results.

> I think we're drawing the wrong conclusions from high-dose rat tests. They are testing enormously high doses--the maximum tolerated dose in the rats or the mice, which means you find the level that causes overt toxic effects and back off just a little bit and feed the animal that amount every day for a lifetime. That sends toxicologists up the wall because that's a very high dose, *and they are afraid that will do something that isn't relevant to low doses.*

In short, it is the high does of synthetic substances that is the causes of the observed cancers, not the substances per se.

Ames notes that the similar animal tests of natural chemical substances reveals about half of those to be carcinogenic. Ames thus claims that "man-made chemicals are no more carcinogenic than natural chemicals and the exposure of humans to synthetics, outside of occupational situation is much smaller than to natural chemicals:

> Of course. almost all the world is natural chemicals, so it really makes you rethink everything. A cup of coffee is filled with chemicals. They've identified a thousand chemicals in a cup of coffee. But we only found 22 that have been tested in animal cancer tests out of this thousand. And of those, 17 are carcinogens. There are 10 milligrams of known carcinogens in a cup of coffee and that's more carcinogens than you're likely to get from pesticide residues for a year!
>
> We're eating natural pesticides, which are natural chemicals that plants use to try to kill off insects that try to eat them. And we eat roughly 1,500 milligrams of them per day. We eat 0.09 milligrams of synthetic pesticide residues. So we're talking about incredibly tiny amounts of synthetic pesticides, and yet the same percentage of natural chemicals come out positive.

Workers and neighbors at manufacturing and waste disposal facilities are exposed to toxins. Maps produced by The National Cancer Institute reveal that cancer seems to cluster in areas densely populated with industrial sites. Although, such clusters are rarely "statistically significant" environmentalists refuse to see such clusters as purely random.

Ames' critics also emphasize that while natural carcinogens are decomposed, that is, they do not accumulate in the environment, synthetic substances do build up and are magnified by the food chain so humans could be exposed to ever heavier doses over time. For example, synthetic pesticides are now measurable in groundwater in many states, and the concentrations are increasing over time. Many pesticides, and industrial poisons such as PCBs, are measurable in all the world's oceans, and even in the polar ice caps. There is compelling evidence that wildlife is being harmed (in some instances, driven to extinction) by this buildup of exotic chemicals throughout the global ecosystem. This leads to a third criticism; Ames focuses on cancer and ignores the other effects humans and on other species.

Even if Ames is correct and synthetic chemicals cause only a small fraction of all cancers, cancer is not the only threat to health consequent to the emission of billions of pounds of pesticides and other toxic substances into the ecosystems each year. Over the past decade, a significant corpus of research has indicated that many chemicals damage the nervous, immune and endocrine systems of wildlife (fish, birds, and mammals) and humans. According to these studies, one clear result is reproductive and developmental damage in the affected species, and an increased likelihood of succumbing to bacterial and viral infections as well as cancers

Ames contends that .too much of our nation's resources are used in regulating pesticides and other synthetic chemicals relative to the risks they pose in *causing cancer in humans*. He argues for example, that the average daily intake of DDT, a banned insecticide that has saved millions of lives around the world by killing insect vectors that spread diseases such as malaria, has the same carcinogenic risk as drinking one can of beer (a substance containing natural

carcinogens) every 8000 years. Critics emphasize first that DDT was losing its effectiveness as an insecticide. Secondly, the note that DDT was also having devastating effects on other species, most notably birds.

Finally, the critics insist that Ames fails to take into account the synergistic effects that are produced when people are exposed to several of these substances. Rat experiments test the effects of a single substance acting alone. But, there is research that has shown that effects of these substances is not additive. Scientists and the National Institute for Occupational Safety and Health reported the "alarming finding" that, "when animals were exposed to several [chemical] agents at once, the animals (or their offspring) experienced a dramatically increased number of adverse health effects."

Our Stolen Future

> The evidence implicating natural estrogen is pretty convincing .If a woman starts having her period early in life or goes through menopause late, her chances of getting breast cancer are increased. Not having a baby at all, or having the first baby late in life, increases the likelihood of breast cancer. Having more babies is more protective against breast cancer; having more than five is most protective. Breast feeding seems to be protective, but it is unclear exactly why this is so. Having one's ovaries surgically removed is very protective; in pre-menopausal women, the ovaries are the major source of natural estrogen. In sum, for unknown reasons, under some circumstances, prolonged exposure to natural estrogen increases the likelihood of breast cancer in some women- Rachel's Environmental & Health Weekly

. The Great Lakes were so loaded with human waste and phosphates that prolific algal growth sucked them dry of oxygen leaving to be declared virtually "dead". By the 1990s the Great Lakes had been cleaned of phosphates and human waste, but doubts about the health of the lakes remained. Zoologist Theo Colborn, while reviewing thousands of scientific studies on the animals of the Great Lakes region came to believe that although "broken eggs littering the bird colonies may have disappeared,[97]...biologists working in the field were still reporting things that were far from normal: vanished mink populations; unhatched eggs; deformities such as crossed bills, missing eyes, club-footed cormorants; and a puzzling indifference of usually vigilant nesting birds about incubating eggs" [Colborn p. 15]. Theo Colborn realized that she had been so focused on looking for evidence of cancer that she had overlooked rather dramatic evidence that something was altering the reproductive behavior and capacity of animals. As she looked at the world-wide data from this new perspective she was astounded. She found numerous reports in the scientific literature that synthetic chemicals seem to mimic the female hormone estrogen. There were reports of feminized alligators with shrunken penises. In California female sea gulls had taken to living as couples as male sea gulls showed no interest in mating or minding the nest. Physical examinations of the male gulls discovered they had developed female reproductive

[97]This is an illusion to the effects that DDT had on bird eggs. DDT caused bird's egg shells to be too thin and therefore to break prematurely.

organs. When she looked for studies dealing with humans she discovered that all over the world scientists have been reporting a decline in the average male sperm count over the past 50 years of about 50% and a coincident rise in the incidence of testicular cancer [Colborn p. 9].

Because these chemicals mimic estrogen they produce as estrogen overload in females and may be linked to the ongoing epidemics of endometriosis and breast cancer.[98] Known risk factors[99] can account for only about one-third of breast cancer incidence. Many women who acquire the disease lack any of the conventional risk factors [Davis & Bradlow p. 166,167]. There is accumulating a body of evidence which suggests that the rise in the incidence of breast cancer since the early 1980s may be the consequence of so-called xenoestrogens (foreign estrogens) which increase women's exposure to the effects of estrogen and thus raise their chance of developing breast cancer [Davis and Bradlow p. 167]. These xenoestrogens have many pathways into the body. While drinking polluted water or breathing polluted air might provide such a pathway, the most likely source of high concentrations of xenoestrogens is animal fat. Xenoestrogens, like DDT itself a xenoestrogen,, tends to accumulate in the fat of animals at the top of the food chain or which feed on large volumes of contaminated grass or feed grains [Davis & Barlow p. 168]. [100] At present the hypothesis that xenoestrogens promote breast cancer is "speculative," especially as the exact mechanism of causation is not understood, but the evidence is mounting quickly.

In 1992 two Tufts Medical Center researchers were perplexed when they observed that breast cancer cells in both an experimental and a control group cultures were growing unexpectedly and extraordinarily fast. After a very long process or replication and investigation they discovered a substance had been leaching out of their culture trays into their samples. The chemical, they finally discovered[101], was nonylphenol which had been recently added to the

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98. Cancer is excessive cell growth. Hormones stimulate cell growth. The cumulative exposure to Estrogen has been linked to endometrial and breast cancer. Both breast and endometrial cells proliferate in the presence of estrogen. If the pesticides mimic estrogen they can produce increased rates of cancer [Ames & Gold p. 154].

[99] The conventional risk factors are early onset of menstruation, late entry into menopause, never having had or breast fed a child, and being over age 50. Each of these factors increases lifetime exposure to estrogen [Davis & Bradlow p. 168].

[100]32. Xenoestrogens include weed killers and insecticides such as Atrazine, Chlordane, DDT, Endosulfan, Kepone, Methoxychlor and, of course, some PCBs. All of which are found in water and grains and grass. Aromatic hydrocarbons, by-products of gasoline vapors, or exhaust fumes are breathed by everyone [Davis & Barlow p. 169]

[101] The company that supplied the culture dishes impeded the discovery process. It refused to inform the scientists that they had added a new substance to the plastic formula for fear of revealing a "trade secret."

formula in order to make the plastic in the culture dishes more flexible. Tests revealed the chemical acted as an xenoestrogen.

There is also some evidence that the presence of these xenoestrogens in the placenta and in alarming quantities in breast milk may have effects on child development i.e. it may produce behavior problems and reduced cognitive ability.

The link of synthetic chemicals present in adults to birth defects in children was not even considered by physicians because it was widely assumed that the placenta provided a barrier that prevented toxins in the mother from entering the child. The DES experience showed this notion to be a myth.

In 1938 it was discovered that DES (diethylstilbesterone), a synthetic chemical, acted like estrogen in the body. On the assumption that miscarriages and premature births were caused by a deficiency of estrogen, the drug was widely administered to women having these problems. Given the absence of a clinical proof to support this assumption, the prescription of this drug amounted to no less than a "massive human experiment" [Colborn p. 48]. The medical profession was so enamored with DES, that is was prescribed even in normal pregnancies to make "bigger and better babies," to relieve the symptoms of menopause, to suppress milk production after birth, as a "morning after" contraceptive, and to stunt the growth of females who were growing "unfashionably tall," read masculine [Colborn p. 48].

In 1952 clinical studies found that DES had no effect on the success of pregnancies or early infant mortality. Following its "do no harm" philosophy the Federal Drug Adminstration took no action [Colborn p. 54]. Between 1966 and 1969, doctors and the Massachusetts General Hospital noticed a cluster of a very rare vaginal cancer. It was traced to DES; the mothers of these women had been given the drug during a crucial period of their pregnancy. Further, animal studies found that effect of DES was not dose dependent. All that was required was a single dose at a critical time, usually within the first three months, during the formation of the fetus to disrupt and distort fetal development [Colborn p. 51]. DES, animal studies reveal, tends to sensitize the fetus to estrogen so all the ill effects of estrogen (cancer of the uterus, breast and prostate) are exaggerated. Moreover, high does of estrogen tend to feminize males and musculizes females.

Follow-up studies of DES human children revealed that 24% of DES females were bisexual-homosexual for life compared to a population average of 3-5%. Within families DES affected sisters were five times more likely to be homosexual or bisexual for life than non-affected sisters (42% v 8%). There is no evidence that DES affected the sexual preference of males [Colborn p. 65].

Dioxin status as a carcinogen and killer may have been subject to dispute until 1992. [102] In 1991, Dr Marilyn Fingerhut published a study of 5172 workers who had been exposed to

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[102] The same material, waste oil contaminated with dioxin, that was sprayed on the roads at Times Beach was also sprayed on the dirt in a show area of a horse-breeding ranch in Moscow Mills, Missouri. Some humans were sickened, but they survived. However, 43 of the 89 horses exposed died within a year and, of forty-one new born only one survived died. Most of the cats, dogs and barn sparrows sickened and died [Colborn p. 116, De Perna p. 93].

dioxin in the workplace. Of these workers 1520 had been exposed to dioxin more than 20 years before for a duration of at least one year. This group had 900% the normal rate of soft-tissue sarcoma (cancer of the connective tissues), 42% more cancer of the respiratory system than would be expected in the general population [REHW #219 2/6/91]. Overall, for all cancers, the incidence in this group was 46% higher than in the general population. One commentator on the study noted that the implicit rate of cancer of 2/1000 for soft-tissue sarcoma far exceeds the EPA one in a million standard.

Dioxin has now also been implicated in damage to the reproductive system by acting as a hormone. Animals studies on rats at the University of Wisconsin showed that large doses of dioxin reduced testosterone levels, lowered sperm counts in adult rats and caused a loss of mass of their reproductive organs. However, only small doses in the womb and through mother's milk were required to produce similar symptoms. The researchers concluded that fetuses and young rats were 100x more sensitive to dioxin than adults [Colborn p. 119].

At present there are 51 synthetic chemicals, all ubiquitous in the environment, that have been shown to mimic hormones and disrupt the human hormone balance. Thousands more, including some 209 PCBs, 75 dioxins, and 135 furans, remain to be investigated [Colborn (Sierra) p.34]. Critics have argued that there is little to be concerned about. After all, they argue humans have been in contact with naturally produced pesticides, known to produce cancer in rodents, and with naturally produced estrogens. For example, Ames & Gold insist that Rachel Carson's assertion that, "for the first time in the history of the world, every human being is subjected to contact with dangerous chemicals, from the moment of conception to the moment of death" is dead wrong. They contend, quite correctly, that "the vast bulk of the chemicals humans are exposed to are natural, and for every chemical some amount is dangerous" [Ames & Gold p. 158]. TCDD (dioxin), they admit, is "an unusually potent rodent carcinogen, but seems unlikely to be a significant human carcinogen at the levels to which the general population is exposed." [Ames & Gold p. 159]. This translates into the assertion that dioxin has not contributed very much to the overall incidence of cancer because its incidence in low. It does not mean that people who live above or near superfund sites containing dioxin or near incinerators, a major producer of dioxins, are at little additional risk of cancer.

Ames& Gold then provide a long list of "natural" substances that are proven "rodent carcinogens:" ethyl alcohol found in beer and wine, caffeic acid found in apples, coffee, pears, plums, and celery; alflatoxin found in peanut butter; saccharin found in diet soda, to mention just a few. Indeed, there are more rodent carcinogens by weight in a cup of coffee than there are pesticide residues on all the food eaten in a year [Ames & Gold p. 159].

Plants produce chemicals to protect themselves from predators, when humans eat these plants or the animals that eat these plants we are eating these natural pesticides. About half of these natural pesticides cause cancer in rodents. Many plants (about 300) such as parsley, garlic, sage, wheat, rice potatoes, carrots, peas, alfalfa spouts and soybeans also produce some 20 natural estrogens. These plants control the rate of predation on them by controlling the population of predators. Women have long understood the contraceptive properties of certain plants such as Queen Anne's Lace. The Greeks used pomergrants for contraception. It would appear that these natural estrogens have not hindered human fertility nor do they appear to cause cancer or other disease. Can one assume then that chemicals, synthetic or otherwise pose little threat to human life as long as exposures are small? The answer is no.

First, recent research on endocrine disrupters show that problems are not dose related. A very small quantity at a critical time can be very dangerous. Second, humans have co-evolved with natural substances. One would expect that acute sensitivity would have been weeded-out by now. The same cannot be said about recently developed chemicals with which the human body has no evolutionary experience [Colborn p.81].

Microparasitism

Worldwide, infectious diseases are the leading cause of death. Infectious diseases account for 13 million deaths each year [M.L.Cohen, Changing Patterns of Infectious Disease, *Nature*, V.406(6797):762-767, Aug. 2000] In the United States, which has brought the major killer diseases like malaria, cholera, and TB under control, infectious disease ranks as only the third leading cause of death [S. Binder et al, Emerging Infectious Diseases: Public Health Issues for the 21st Century, *Science*, V284(5418)1311-1313, May 1999]. Between 1980 and 1992, in the United States, the death rate where infectious disease was an underlying cause increased 58% (41 to 65/100,000) [Robert Pinner et al [1996]. Trends in Infectious Diseases Mortality in the United States, *JAMA*, 275(3), p. 189]. Obviously, increased death rates from HIV (0 to 13/100,000), now the primary killer of men aged 25-44, accounts for a great deal of this increase, however, even with the effects of HIV mortality removed the death rate from infectious disease increased by 22% [*ibid*, p. 192]. Today, however, according to M.L. Cohen of the US Center for Disease Control, " changes in society, technology and the microorganisms themselves are contributing to the emergence of new diseases, the re-emergence of diseases once thought controlled, and to the development of antimicrobial resistance." [M. L. Cohen (2000), op cit.]. The fact that human activity has promoted these trends has led some observers to refer to what we call "emerging diseases" as "diseases of human progress" [R. Gomez-Lus et al (2000), Emerging and Re-Emerging Pathogens, *International Journal of Antimicrobial Agents*, V16(3):335-339]. One should interpret "human progress" here

> In the Fall of 1998, the United Nations announced that it was joining forces with the world's poor people. Malaria kills about one million people every year. Children are especially vulnerable. Every thirty seconds, somewhere in the world a child dies from malaria. The problem is particularly acute in Sub-Saharan Africa that claims 90% of all malaria cases [NYT 10/31/98]. Even when it does not kill, malaria produces such severe anemia it completely debilitates people, especially women and children.
>
> Despite this enormous toll of morbidity and mortality, the New York Times reported that "research on prevention and cures for malaria has been all but nonexistent in big pharmaceutical companies for more than two years because the drugs proved not to be money-makers" [NYT 10/31/98]. Admittedly the problem is a difficult one. Both the parasite and its mosquito vector quickly develop resistance medicines and insecticides. The point is, however, the "for-profit" sector has abandoned the problem, leaving it to the non-profit sector to deal with. This is a consequence not of uncaring people in drug companies, it is a product the market system - it is a rather unfortunate aspect of markets that they do not take very good care of poor people, such as Africans, because there is little profit in producing a product that would help people who cannot afford to buy it.
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> In 2002, scientists reported they had found a way to genetically alter mosquitoes so they would no longer transmit the malaria plasmodium. They also reported difficulty in getting funding for further research because malaria "is a poor country's disease"[Providence Journal, 5/23/02]

to mean "capitalist development." While in the common parlance "economic development" is viewed as a benign process, and surely it could be, it is nonetheless true, that when "development" takes place under capitalism, it usually leads to a dramatic deterioration in the quality of life of the masses of people. Capitalist development benefits relatively few while most of the others suffer from degraded ecosystems, economic, social and cultural dislocation, and deteriorating health which is often due to the poverty, squalor, and the disease promoted by "human progress."

Many pathogens have been extinguished by humans, or are on the verge of extinction e.g. small pox by 1980, and poliomyletis by 1991(at least in the western hemisphere). Measles, now on the verge of eradication, only 15 years ago "was the most lethal agent in the world with 3 million or more deaths per year. Measles remains one of the leading causes of childhood death [C.A. Quadros et al [1996] Measles Elimination in the Americas, JAMA 275(3), p. 224]. The full eradication of measles would be possible if all children were properly immunized. The most obvious obstacle to the realization of this goal is economic and social. Between 1989 and 1991, a measles epidemic emerged in the United States. The virus claimed 123 lives, most often those of "pre-school aged children, particularly (children from) minority groups residing in inner-cities" who had remained unvaccinated due to lack of access to the health care system [Quadros et al, op. cit. p. 226].

Some pathogens thought extinguished have been making a comeback and wreaking havoc on the human population once again. For example, strains of mycobacterium bovis (TB) and Streptococcus pneumoniae (Pneumonia) have evolved that are resistant to antibiotics and impossible to treat [Gomez-Lus (2000), op. cit]. In 1996 it is expected that, over the next decade, TB would take 30 million lives Rita Colwell (1996) Global Climate and Infectious Disease: The Cholera Paradigm, *Science*, 274(20 December), p. 2025].

By taking 3.5 million people's lives in 1998, mostly in the developing nations, pneumonia remains the single largest killer among the infectious diseases. It is a matter of great concern now that in some countries as many as 70% (South Korea) of cases of ARI (acute respiratory infection) the disease has proved resistant to at least one of the first-line anitmicrobials e.g. penecillin. Treatment is not more costly, especially to those on the developing nations

Dyptheria which has been only rarely observed in the US since WWII. But, in some areas, notably the nations in the former Soviet Union, due to a deterioration in public health systems and declines in immunization, both of which are the consequence of economic difficulties, Diphtheria is making a startling comeback. In the new independent states the number of Diptheria cases increased from under 1000 in 1989 to 47,802 in 1994 [AMA Council on Scientific Affairs [1996], Epidemic Infectious Disease Risks: Striving for Perspective, *JAMA* 275(3), p. 181].

Cholera, once considered a 19th century disease, has re-emerged in the form of the 7th global pandemic that has killed tens of thousands since 1961 in Bangladesh, Africa, and as recently as 1998 in Western South America (Peru, Ecuador, Bolivia, Columbia, Chile). After the sixth pandemic ended in 1926, it was believed that Cholera had been defeated because of improvements in sanitation and the protection of water supplies, but it was not to be [Colwell, op. cit p.2026]. Moreover, while oral rehydration therapy is critical in the treatment of cholera, the bacterium has shown a growing resistance to tetracycline, the main-line antibiotic used in its treatment. Other vector-borne scourges such as Malaria, Dengue Fever, Yellow Fever, and Encephalitis are being observed in areas where they have never before appeared [e.g., higher

elevations] and in areas where it was thought they were controlled [Gelbspan 1996 p. 147-149].

"The global ecosystem is constantly changing, influencing the micro- and macroenvironments in which humans and their microbial companions reside and interact" [A.J. Pollard (2000) Emerging Infectious Diseases in the 21st Century, *Current Opinion in Infectious Diseases*, v. 13(3):265-275]. Diseases of various kinds have posed new problems to humans primarily because, over time, humans have changed and continue to change the nature and the location of their economic activities. The latter changes alter ecosystem balances often in favor of sustaining diseases and disease vectors. Most notably the process of urbanization places dense populations of malnourished people in squalid, unsanitary environments, that prove to be a felicitous environment for rats, lice, and mosquitoes and various waterborne diseases. At present, according to the WHO, "the worst-off cities are growing fastest. The population of the world's big cities is expected to double, to 5 billion, by 2025, and only one of the ten largest is in a developed country[103] (Tokyo, Japan) [JAMA [1996], Medical News and Perspectives, 275(3), p. 178].

Recall that it was the shift from hunting and gathering to pastoralism and agriculture that first brought humans into contact with animal diseases (e.g. TB, Smallpox, Measles, Diphtheria, Influenza, Bubonic Plague, Typhus) and/or diseases that require a dense population of hosts living in squalid conditions. One cannot overemphasize the "socio-economic" component of disease.

The Poverty Paradigm: Drug Access and Resistance

More than any other issue, poverty and inadequate access to drugs continue to be a major factor in the development of resistance to drugs. In many developing nations drugs are freely available - but only to those who can afford them. This means that most patients are forced to resort to poor quality or counterfeit, or truncated treatment courses that invariably lead to more rapid selection of resistant organisms - WHO, Overcoming Antimicrobial Resistance, Infectious Disease Report, CH. 3, 2000

The ability of the body to fight disease depends on its overall health. Health, in turn, depends on nutrition. We know that during the neolithic revolution the quality of the human diet declined at precisely the time humans were first exposed to new pathogens. The associations between TB, Typhus, Cholera, and Typhoid and urban squalor, that is, poverty, crowded poorly lit and ventilated housing, malnutrition, and poor sanitation, are unquestioned. That malnutrition compromises the human immune system is well established fact in the health literature. Indeed, recent research done at Johns Hopkins University found that malnutrition was a factor in 50% of child deaths from infectious diseases worldwide [A.L. Rice et al.(2000), Malnutrition as an underlying cause of childhood deaths associated with infectious diseases, *Bulletin of the World Health Association* v78(10):1207-1221].

Moreover, the expansion of contact with distant human populations through trade and conquest brought humans into contact with diseases for which they had no natural immunities. History has shown the devastating impact imported diseases had on Athens, the Roman Empire,

[103] The other nine are, Bombay, India; Lagos, Nigeria; Shang-hai, China; Jakarta, Indonesia; Sao Paulo, Brazil; Karachi, Pakistan; Bejing, China; Dhaka, Bangladesh; Mexico City, Mexico JAMA [1996], Medical News and Perspectives, 275(3), p. 178].

Medieval Europe and the New World.

Human economic activities also changed the natural environment in ways that encouraged disease. Agriculture produced ideal habitats for parasites such as the schistosome, and vectors such as mosquitoes, lice, mice and rats. Irrigation provided an ideal environment for the blood fluke that causes schistosomiasis. Slash and burn, or swidden agriculture in West Africa cleared forests and created new breeding areas for the mosquitoes that carry malaria. Malaria was unknown in West Africa before agriculture [Ponting p. 227]. Dense settlements provided an ideal habitat for diseases that spread thorough human contact (pneumonic plague, smallpox, measles, influenza) or through vectors such as lice (typhus), fleas (plague), mosquitoes (malaria, yellow fever, dengue fever, dengue hemorrhagic fever, encephalitis) or water-borne bacterial diseases such as cholera, typhoid and dysentery.

> In 1783, British historians calculated that some 20,000 pilgrims to the Indian holy site of Hardawar succumbed to cholera. Within months the bacilli spread outwards toward China, north to Russia and southwest to the middle east. By 1831, cholera infected nearly half of the Haj faithful making the annual pilgrimage to the sacred sites of Medina and Mecca - the fatal consequence of drinking from a single ritualistic source of contaminated water. Dehydrated and shedding vibrios, dying pilgrims crept homewards depositing bacteria along key transportation routes. The great ports f Alexandria and Istanbul were soon staggering under a cholera epidemic that subsequently radiated outwards throughout the entire African littoral, into the Balkans, up the Danube and onwards towards Hungary leaving behind a trail of corpses, orphans, economic ruin and contaminated water and food - World Health Organization, Infectious Disease Report, Overcoming Antimicrobial Resistance, 2000.

The migration of human populations also spread disease. The Mongol migration brought the bubonic plague that wiped 1/3 of the European population. The movement of the Chinese south into the Yangtze River area exposed them to malaria, schistosomiasis, and dengue fever. The same thing happened as people moved from the Indus valley to the Ganges Valley. Even religious pilgrimages have proven a most efficacious vector for the spread of disease [see box].

The epidemiological implications of economic activities have generated little concern in the past half-century or so primarily because modern sanitation, antibiotics, and vaccines have greatly reduced the incidence of disease in both the industrial and the pre-industrial world. Several diseases, including smallpox have been declared eradicated. Indeed, when it appeared that more children died from the vaccinations than could have been expected to die from the disease, in the U.S., the utility of continuing measles vaccinations was questioned and the program of immunization was suspended.

Mark Twain after reading his obituary in a newspaper, quipped that, "the announcement of my death was premature." The obituary on infectious disease has also proven "premature." Recent news includes reports of epidemics: bubonic plague in India; cholera in Bangladesh, Africa, India and Peru; diphtheria and TB in Russia [50,000 dead]; yellow fever in Africa; dengue fever in Australia, Central America, and East Africa; and of course new disease such AIDS, and new African rainforest diseases such as Marburg, and Ebola viruses and Labrea black fever, which is one of a “half-dozen deadly and little understood viral diseases emerging from rainforests in Latin America”[Rita Colwell (1996) Global Climate and Infectious Disease: The Cholera Paradigm, *Science*, 274(20 December), p. 2025]. Also increasing in the United States

and Europe are the so-called food borne bacterial (salmonellosis, listeriosis, E-Coli 0157:H7, leptospirosis) and viral (Hepatitis A) and Bovine Spongiform Encephalitis (Mad Cow Disease) Malaria still kills two million people each year worldwide [Rita Colwell (1996) Global Climate and Infectious Disease: The Cholera Paradigm, *Science*, 274(20 December), p. 2025] and Cholera is once again stalking the world. Between 1991 and 1995, Cholera infected and sickened one million people and killed 11,000 on the west coast of South America [World Resources Institute [www.wri.org/wri/wr-98-99/cholera.htm, 4/22/01].

It was a first believed that Cholera was recently brought to South and Central America in the bilge of a ship from Southeast Asia. The Latin American strain of *V. Cholerae* is similar to but not identical to that found in Bangladesh. The Latin American strain is genetically identical however, to strains found in the bilge, ballast and sewerage found in ships traversing the region. Nevertheless, the rapidity of the spread of the disease[104] belies attribution of the disease's etiology to a single or even a few local incidents of bilge release. In addition to finding its way into drinking water, the cholera bacterium infected fish and shellfish. Peruvians also used untreated sewage to fertilize fruits and vegetables. Since the Peruvians eat fish and shell fish, and (unwashed) fruits and vegetables raw, it was accepted that this was the pathway into the general population. Once in the population, the disease, due to poor sanitation systems, infected the local water supply. While local water in Lima was filtered before it went into the distribution system, the systems are old, the pipes are cracked and pressures are not maintained, so ambient infected water can pass into the system. Moreover, many towns and slums had independent wells that were not filtered. Add to this the fact that 5-6 million people in Lima did not have proper latrines and one has the makings of a disaster. To make matters worse, Trujillo and Lima and other Peruvian cities either suspended or greatly reduced water chlorination. The government of Lima says this was done because, according to the US EPA, water chlorination posed a cancer risk[105]. Indeed, EPA critics have blamed the Cholera epidemic on the "junk science"[106] done at the EPA. Others have blamed the inadequate chlorination on "practical and economic difficulties"[Christopher Anderson (1991)Cholera Epidemic Traced to Risk Miscalculation, *Nature*, Nov. 28]. To date there has been nearly a million victims of this epidemic and 11,000-

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[104]Within just a few days, the disease had spread from Chancay, a coastal state just 40k north of Lima. The next day an outbreak was reported 400k north of Chancay. By Feburary the plague had spread to every state along the coast a distance of about 2000k. Within 16days the mountain states to the east were infected and in a mere 29 days the disease had reached the Amazon basin. [www.coloradao.edu/geography/gcraft/warmup/cholera/cholera.html, p. 3/5, Rita Colwell, 1996, p. 2027].

[105]Chlorine reacts with the by-products of organic decay in water to form several potential carcinogens, most notably chloroform and trihalomethanes (THMs). The EPA limits the amount of these substances permitted in drinking water. EPA studies in the 1970s found an elevated cancer risk (1/10,000 compared to the allowable baseline of 1/million) should the concentration of THMs reach 100ppb [Christopher Anderson, Cholera Epidemic Traced to Risk Miscalculation, *Nature*, Nov. 28, 1991]

[106] "Junkscience" is the label attached by right-wing, anti-environmentalists to any research that shows chemicals cause human health problems, or that global temperatures are rising due to human activities etc..

12,000 have died. Sometime later an airline delivered 12 infected people to Los Angeles, but no secondary cases were reported. The disease has also been found in plankton off the coast of the U.S. in the Gulf of Mexico. [Providence Journal 4/9/95].

Malaria

There has been a "marked resurgence" of malaria since 1973 [Patz et al, p. 218]. In 1996, according to the WHO, world-wide some 300-500 million people are infected with Malaria. In 1990, in Sub-Saharan Africa alone, malaria claimed 805,300 lives. Globally, the annual toll in "life-years" lost to malaria is over 35 million[107] [Piero Olliaro at al [1996], Malaria: the Submerged Disease, *JAMA*, 275(3), p. 230] The toll taken on children is particularly high. A experiment in Gambia, West Africa revealed that the use of insecticide-treated mosquito nets reduced all-cause mortality in children 1-4 years of age by 63%, a fact that suggests that death due to malaria is often attributed to other causes, and thus the mortality toll noted above is too low Piero Olliaro at al [1996], Malaria: the Submerged Disease, *JAMA*, 275(3), p. 230]. The incidence of malaria is expected to spread over the next few decades for several reasons. First, human economic activities, deforestation being one of the more notable, are creating new habitats for malaria vectors. Second, the malaria plasmodium, *p. falciparum*, has developed resistance to the commonly used antimalarial drugs, especially the mainstay chloroquine, and there seems to be no effort to develop new ones [see box]. The WHO reports resistance to chlorquine at a rate of about 80% in the 92 countries most afflicted by malaria [WHO, Overcoming Antimicrobial Resistance, Ch 4, 2000]. Moreover, some 50 species of mosquitoes have developed resistance to insecticides. Third, climate change, i.e. global warming, is expanding the range of the mosquito vectors northward and to higher altitudes [J.A. Patz et al [1996] p. 218]. It is appropriate then to classify malaria as an emerging or reemerging disease [Olliaro et al p. 233].

The climate connection

Global warming, whether the result of human activities or natural trends, threatens humans with an increase in microparasitism - "a very small change in temperature can have a large effect on the spread of disease"[Providence Journal] 4/9/95]. Warmer water is particularly propitious to the spread algae and plankton [e.g., red tides] which harbor the cholera bacteria. Recent research has blamed the periodic outbreak of Cholera in Bangladesh and the massive outbreak in Peru on the cholera bacteria harbored in zooplankton. On land, warmer temperatures and higher levels of rainfall expand the range and stimulate the growth of the mosquito population producing more risk of malaria, dengue fever, encephalitis and yellow fever.

There appears to be an emerging consensus that there is a connection between climate change and the spread of infectious disease. Reports published in the *Lancet*, the British Medical Journal and *The Journal of the American Medical Association* (JAMA) published in 1994 are 1996 express not the slightest ambivalence on this point [Gelbspan, 1996 p. 147-48]. The 1996 article in JAMA (Journal of the American Medical Association):

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[107] For TB the number is 46,45 million and all cancers take 80 million [Olliaro et al p. 230].

> The incidence of mosquito-borne diseases including malaria, dengue, and viral encephalitis, are among those diseases most sensitive to climate. Climate change would directly affect disease transmission by shifting the vector's geographic range and increasing reproductive and biting rates and by shortening the pathogen incubation period. Climate-related increases in sea surface temperature and sea level can lead to a higher incidence of waterborne infectious and toxin-related illnesses, such as cholera and shellfish poisoning. Human migration and damage to health infrastructures from the projected increase in climate variability could indirectly increase contribute to disease transmission. Human susceptibility to infections to infections might be further compounded by malnutrition due to climate stress on agriculture and potential alterations in human immune system caused by increased flux of ultraviolet radiation [J. Patz M.D. et al, Global Climate Change and Emerging Infectious Disease, *JAMA* 275(3), p. 217]

The most notable cases are the mosquito-borne and water-borne diseases, most notably, but not limited to malaria and cholera. The link between climate change and cholera seems well established. That between malaria and climate is somewhat more controversial. There is no doubt that there has been a "marked resurgence of malaria since 1973" [Patz, et al, p. 218]. Some of this is the result of the development of resistance to insecticides by some 50 species of mosquitos [Patz et al, p. 218]. But there is evidence that malaria has extended ino new areas as temperature and rainfall has increased. This has been especially notable at higher altitudes [Patz et al p. 218]. But there appears to be considerable confusion as to exactly what constraints temperature has historically imposed on the viability of the malaria plasmodium or on the vector. Historically, dengue and yellow fever have occurred as far north as Boston suggesting the *Ae. Aegypti* mosquito can survive in these climates. Malaria was also common in Europe, including in England during the "little Ice Age!"[Paul Reiter [2000], From Shakespeare to Defore: Malaria in England in the Little Ice Age, Center for Disease Control, Emerging Infectious Diseases, 6(1)].

In both cases, however, in the final analysis, the factors of fundamental importance are the socio-economic.

Dengue Fever

In July of 2002, a state of emergency was declared in Honduras as dengue hemorrhagic fever broke out in all 18 provinces of the Central American nation. El Salvador, Nicaragua, Costa Rica and Guatemala have also experienced outbreaks, if to a lesser degree. The reason for the outbreak is the unusually heavy rains that fell over all of Central America for several months (May-July) which promoted the proliferation of *Aedes egypti* mosquito, a vector of the disease [Promed]. Until recently, Dengue fever, while surely a serious affliction, was rarely fatal and was confined to the tropical areas that offered felicitous environments for its mosquito vectors. Although it has been around for over two hundred years, there were no major outbreaks of dengue until the 1950s [White & Fenner, p. 442]. In the past decade, the disease has spread to the western hemisphere and in a more fatal form - hemorrhagic dengue fever. This new form of the disease was first observed at the turn of the century in Australia. The first epidemic was observed in Manilla in 1953-54 [White & Fenner, p. 442]. Consequent to the emergence of this variant of the disease, mortality has increased. Dendue hemorrhagic fever is a serious health problem in

South and Central America. The spread of the disease, and the increase in its mortality rate is attributed to human migration and to global warming.

The symptoms of dengue fever (den-gay) were well known in West Africa for centuries before during an outbreak in Philadelphia in 1780, Dr. Benjamin Rush named its American manifestation "bilious remittent fever." The disease came to be more popularly known during this period as "breakbone fever." The disease causes high fever, headaches, persistent vomiting, diarrhea and joint and muscle pain so acute, as Dr. Rush put it, "exquisitley severe,"as to mimic that of a broken bone [Margaret Humphreys, Dengue Fever: Breakbone Fever, in K. Kiple ed, 1997, *Plague. Pox, & Pestilence*, p. 93]. The infection which could be caused by one of four closely related viruses, leaves its adult victims debilitated and depressed for several weeks. In Africa, in Swahili, it was called "denka"[Stanley Aronson M.D., Global Warming and the Spread of Dengue, *Providence Journal*, 4/8/2002, p. A7].

Denka is endemic among large primates, e.g. chimpanzees and old world monkeys in the West African rainforest. As humans moved into the rainforest the disease spread to them. Now, in urban epidemics involving the Aedes egypti mosquito, the virus is sustained by a mosquito-human cycle [White and Fenner, p. 438].

Denka, along with malaria and yellow fever, were introduced to the New World by the slave trade. The disease and its vector, the *Aedes Aegypti,* mosquito[108] stowed away on slave ships bound to the Caribbean and the new world. In Jamaica it was called , and is to this day, "dandy fever." In United States, the Swahili word "denka" was translated as "dengue"[Stanley Aronson M.D., Global Warming and the Spread of Dengue, *Providence Journal*, 4/8/2002, p. A7]. In 1780, Dr. Rush observed that the disease seemed to end when the summer ended. It would be over 100 years before physicians would understand why epidemics of dengue, malaria, and yellow fever ended in the fall when the activity of mosquitoes declined [Humphreys, p. 94].

Although extremely painful, the disease is rarely fatal to adults. For children, it is only a minor ailment with, at worst flu-like symptoms, but which provides lifetime immunity. The disease can be endemic with no serious health consequences unless a new variant of the virus is introduced. The Dengue viruses are in the flavivirus[109] family which includes the yellow fever virus. Unfortunately, infection by one serotype of this virus does not provide immunity to the other three. Indeed, when infected by another serotype, a person may experience a severe allergic reaction manifest in an over response of the immune system which produces the hemorrhagic form of the disease [Humphreys, p. 92]. The disease is only fatal when contracted in

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[108]The virus can be carried by any member of the urban dwelling Aedes family. Aedes albopictus, known as the "tiger mosquito" has spread all over the American Southeast "setting the stage for the rapid spread of the dengue virus sometime in the future [Humphreys, p. 92].

[109]The genus flavivirus is one of two major groups of arthropod-borne viruses (arboviruses are carried by mosquitoes, ticks, sandflies and midges). Of the 70 viruses in this group about 13 cause illness in humans. The symptoms range from fever, to rashes to hemorrhagic fevers and Hepititis C. Flaviviruses may cause encephalitis or a fever/arthritis/rash syndrome. The four most bothersome to humans are dengue, yellow fever, hepatitis C and Japanese encephalitis [David O. White & Frank Fenner 1994, *Medical Virology*, p.p. 443,436]

its hemorrhagic form. The hemorrhagic form occurs mostly in children and is fatality rate of about 30% [Humphreys, p. 92]. The children who develop the hemorrhagic form have ben previously exposed to the another serotype or have inherited immunity to another serotype from their mother [White & Fenner, p. 436].

There is no cure or vaccine for dengue. Only analgesics for pain[110] and fever, and fluids for the prevention of dehydration are indicated [Humphreys p. 93]. The hemorrhagic form of the disease is becoming more prevalent as people carrying various serotypes of the virus migrate to other parts of the world, thus exposing vulnerable populations s\to a serotype to which they may be hypersentive.

At present several billion people live in areas when they are at risk of dengue fever and there are about 100 million new cases each year [Aronson]. While not often fatal, the disease imposes an enormous burden in health care costs and lost labor in the predominantly poor nations it strikes. Resources devoted to the care of victims and mosquito control cannot be used for economic development programs. For example, between 1977 and 1987, Puerto Rico suffered nine dengue epidemics. In terms of health care costs, labor lost, and lost tourism revenues, dengue cost Puerto Rico about $100 million [Humphreys, p. 97]. In 1981, there were 340,000 cases in Havana, Cuba. The cost of stopping the epidemic, primarily by eradicating the mosquito vector, was $100 million [Humphreys, p. 94]. The following year there were over a million cases in New Delhi,, India [Aronson].

Most significantly there has, of late, been a disturbing increase in the incidence of the hemorrhagic version of the disease, and a consequent increase in mortality rates. It is speculated that the massive migration of human populations over the past few decades has merged many different disease pools. Thus, many populations may now be exposed to more than one serotype of the dengue virus.

The “tiger” mosquito can carry the dengue viruses. Its range is climate controlled. This very aggressive pest migrated from Southeast Asia to Houston, Texas, probably in shipload of used tires from Japan [Arno Karlen 1995, Man and Microbes, p. p. 160]. The tiger mosquito thrives in small puddles like those found inside used tires, birdbaths, a flower pot, a rumpled grill cover and the multitude of other water-holding nooks and crannies presented by the urban environment. It is now found in 17 states including Oklahoma, and Nebraska, and states as far to the north as Iowa, Illinois and Delaware [Karlen, p. 160]. The tiger is aggressive, feeds all day, and will bite any warm-blooded creature. If global warming raises the US average temperature one degree, the “tiger” will move another hundred miles north. Should the virus be introduced into the US, and there can be no doubt that it will[111], millions of Americans will be exposed to this horrible disease and it s “exquisite” pain. Moreover, as immigration continues from Central America, Southeast Asia, China and Africa, all areas where the disease is endemic, it is inevitable that several serotypes of the virus will be introduced, posing the likelihood of an out break of the hemorrhagic version f the disease.

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[110]Dr. Rush adminstered opium for pain and a diet of tea, lemonade, apple juice and wine to maintain their fluids [Humphreys, p. 94].

[111]At present, before passengers on commercialflights frfomWest Africa can deplane at European airports, the cabin is sprayed with insecticide. No suchprecautions are takenin the US [Aronson].

Cholera

It would appear, based on research done at the University of Maryland, that Cholera in endemic in Peru as it is in Bangladesh. *V. cholerae* thrives in brackish water and in the ocean. It can tolerate fresh water (rivers and lakes) only if there is adequate nutrition from organic pollution, e.g. human waste [World Resources Institute [www.wri.org/wri/wr-98-99/cholera.htm, 4/22/01]. In salty water the Cholera bacterium (vibrio cholerae) lives in zooplankton called copepods, the population size of which depends on the population of its food, phytoplankton. The phytoplankton prosper in warm water and sunshine. In cold water, the cholera bacterium can shrink to 1/300th its normal size, in effect, the bacterium can become dormant and survive as a symbiote or commensal to copepods. The quiescent v. cholorae cling to the "sheaths and exoskeletons of the copepods, but can revert to a "culturable state" when nutrients, pH and temperature permit" [Patz et al, p. 220]. In turn, the copepods live in rivers and lakes from which people take drinking water, and they are eaten by fish and shellfish which people then eat.

Thus, cholera did not return to South America, strictly speaking, it never left. Rather, it remained dormant waiting to re-emerge when the right environmental conditions obtained. Indeed, the Asian strain of *v. cholerae* may have "hitchhiked" with copepods as the latter moved eastward on ocean currents. The ocean current system known as the El Nino Southern Oscillation (ENSO), as it moves warm surface waters from the western pacific eastward in part of its cycle, is the most likely vector of the cholera bacterium.

The efficiency with which people move themselves and their cargo can spread disease rapidly from one part of the globe to another. Richard Lederberg, a Nobel Laureate in Biology warns:

> The microbe that felled one child in a distant continent yesterday can reach yours today and seed a global pandemic tomorrow [Providence Journal 4/9/95]

The effect of climate variability on disease can be seen in the recent (1993) outbreak of Hantavirus in the American southwest. Many newly emerging, that is "previously unrecognized," diseases in humans, specifically the hantavirus, have existed in animal reservoirs and emerged in humans only after some sort of environmental change [R. Prinner et al op. cit. p. 189]. Human exposure to hantavirus occurred only after changing environmental conditions produced an explosion in the population of deer mice, the animal reservoir of the hantavirus.

Periodic Movements in the warm water currents off the pacific coast, are known as the El Niño Southern Oscillation (ENSO). ENSO causes alternate periods of drought and rainfall in the southwest. Of late, ENSO has become more erratic, many believe as a consequence of global warming, and has produced extremes of drought and rainfall. In the American southwest, the six years before 1991 had been drought years and as a result the population of mice predators (snakes, owls and coyotes) was extinguished. A year of prolonged, and heavy rains followed. Consequently, the food supply of deer mice exploded by a factor of ten, and in the absence of predators, so did the population of these animals [Jonathan Patz M.D. et al [1996]Global Climate Change and Emerging Infectious Diseases, JAMA, 275(3), p. 217, see also R. Prinner et al op. cit. p. 189] Since these animals carry the Hantavirus, the greater the rodent population, the more likely becomes human contact and infection [Gelbspan p. 150].

Research done at the Maryland Biotechnology Institute has shown that the periodic

outbreaks of cholera in Bangladesh are highly correlated with plankton blooms in the Bay of Bengal [Rita Colwell (1996), Global Climate and Infectious Disease: The Cholera Paradigm, *Science*, V274, 20 December, p. 2029]. The same appears to be true of the South American Episode. In the first four weeks of 1998, Peru reported 2,863 cases of Cholera and 16 deaths, a considerable increase over the 174 cases reported in 1997. The WHO attributes the "large increase" to the "storms and floods caused by the El Niño." [WHO, Communicable Disease Surveillance and Response, 25 Feb, 1998]. The South American plague began in 1991 with the coming of ENSO.

ENSO has been implicated in the outbreak of cholera in Peru. The warm waters delivered off the coast of Peru by ENSO may have awakened *v. cholerae* from its dormant state. Moreover, the warm waters often produce phytoplankton blooms which in turn can lead to an population explosion of copepods and its symbiote, *v. cholerae.* The increased rainfall produced by ENSO also floods coastal waters with nutrients from runoff [Colwell, p. 2027]. Finally, the intense storms produced by ENSO may force ocean water up rivers toward population centers. The Cholera-plankton relationship is now so well-established that NASA now monitors, using remote sensors, the sea surface temperature and sea surface height, as both of these variable seem to predict cholera outbreaks quite well, at least they did for Bangladesh between 1992 and 1995 [B. Lobitz et al, (2000) Climate and infectious disease: Use of remote sensing for detection of Vibrio cholerae by indirect measurement, *Proceedings of the National Academy of Sciences*, USA 97(4):143–43, Feb].

As humans from one part of the world penetrate the far corners of other parts they come into contact with microbes for which they have no natural protection, but even worse they come into contact with viruses that have not co-evolved with humans and thus remain quite virulent when contracted. When humans meet a disease for the first time they have no natural immunity so the kill rate is very high. Only a few humans who have by chance have some immunity survive. At the same time, a virus that is so lethal as to kill all humans will not survive in humans either as it needs a human host. Ebola virus lives in monkeys and is fatal to them. The virus survives by jumping from one host to another. Initially, when it spread to humans it was fatal to them and given the density of the human population would have little trouble jumping (it was transmitted by blood or through inhaling it). Little wonder that the Army and the Center for Disease Control were so concerned when several monkey handlers contracted the virus from infected monkeys. Fortunately, the particular strain of Ebola contracted appeared not to be harmful to humans. If the African virus had been contracted, there would have been serious epidemic of 14th century proportion.

AIDS

As the world entered the 21st century, there were nearly 34 million afflicted with a disease that was unknown just two decades earlier. Since it began in the early 1980s, the AIDS epidemic has extinguished 18.8 million lives, and ruined millions of others. In 1999, AIDS took 2.6 million lives world-wide, but has been particularly devastating on the African continent. Of 34 million HIV+ people in the world, 24.5 million of them live in Sub-Saharan Africa and 4.2

million live in South Africa [UNAIDS 6/2000 Update Report]. In many African countries life-expectancy is plummeting. In Botswana, where 36% of the population is infected with HIV, life expectancy has fallen by 25 years over the past 25 years because of AIDS. One report has called the AIDS epidemic in Africa an "epidemic or orphans" [USA Today 5/12/99] and with good reason. While in the US the disease had produced 70,000 orphans in the United States, 8,700 in Western Europe, 91,000 in Latin America, 200,000 in South and Southeast Asia, it has produced 7.8 million orphans in Sub-Saharan Africa [USA report of data from UNAIDS 5/12/99]. In Zimbabwe, according to the WHO, some 50% of pregnant women are infected with HIV and one of every three sexually active adults is believed to be HIV+. Uganda has lost 2 million people since 1982. In 1986, Cuban officials in Uganda training troops reported that 25% of the Ugandan troops were HIV+ [USA Today 5/24/99].

In Africa AIDS is a heterosexual disease spread primarily by prostitution. The disease follows the routes used by long-distance truckers who plie the Trans-African Highway and frequent prostitutes, women who need money to feed their families, who then infect their husbands and boyfriends, who then infected other women. In the United States, it is primarily a disease of homosexual men, and IV drug users and the women who have sex with the latter. In the US, the disease has had a disproportionate impact on African-Americans.

Blacks and AIDS

In 1980, blacks had an infectious disease death rate of 46/100,000, 13% higher than the population as a whole [R. Pinner et al 1996], Trends in Infectious Diseases and Mortality in the US, JAMA 275(3), p. 191]. By 1992, that rate had risen to 88/100,000, 36% higher than for the population as a whole [ibid]. This increase was primarily due to the increased mortality of black men aged 25-44 to HIV and AIDS. For the population as whole, the death rate from HIV went from zero in 1980 to 15/100,000 in 1992 [ibid p. 191, figure 3].

There is little doubt that Blacks have borne and continue to bear a disproportionate burden of the AIDS epidemic. Between June of 1981 and September of 1990, 152,126 cases of AIDS were reported to the Center for Disease Control. Of these cases 55% were whites and, though only 12% of the total population, 28% were Blacks. Among heterosexuals and children Blacks carried even greater relative risk. Blacks accounted for about 32% of male cases (73% of the AIDS cases among heterosexual men), 52% of the heterosexual women with AIDS and 55% of the afflicted children. Moreover, the time between HIV infection and the emergence of AIDS was significantly shorter for Blacks as was the period between the emergence of AIDS and death [Duh p. 1]. The mean survival rate, once diagnosed with AIDS, was 8 moths for Blacks compared to 18-24 months for whites [Daniel p.14].

As the epidemic progressed AIDS infection grew faster among Blacks and fastest among black females. By 1997 the cumulative number of AIDS cases had risen to 612,078 (511,934 males, 92,242 females, 7,092 children) cases of which 35% were Blacks (CDC semi-annual HIV/AIDS Surveillance Report, Nov 11, 1997]. In 1995, black males were 37% of new cases and black females over 13 accounted for 59% of all female cases in the first 6 months of 1995 [Roderick Conrad, National Center for Policy Research 1997].

According to CDC data reported in 1993, 36% of black males were infected by homosexual sex contact, 38% through IV drug use, and only 6% by heterosexual sex, the

remainder is unexplained. About half (48%) of black women were infected by IV drug use and 34% by heterosexual sex contact. The latter percentages are approximately the same for white women (46% and 38% respectively), but the overall risk of AIDS is considerably smaller for white women. The national incidence rate of AIDS is 111/100,000 adults. For blacks as a whole the rate is 162. For black males the rate is 266 compared to 55 for white males. For Black females the rate is 73 compared to only 5 for white females. In both races, the majority of the women who contracted AIDS did not engage in risky behaviors, but had sex with men who did. AIDS was the leading cause of death of prime-age (25-44) black women in 1993 [Conrad, op. cit.]. Black children account for 60% of the cases where AIDS is contracted in the womb or at birth. AIDS is the second leading cause of death of black children between the ages of 1-4 years in New York [Conrad op. Cit.]. For blacks in New York, New Jersey and Florida the rates are 379,373 and 366 respectively.

It has been speculated that the higher incidence of AIDS among Blacks may be the consequence of a "genetic predisposition," that is a higher frequency of a gene that is alleged to predispose individuals to AIDS. More specifically, it was alleged that Blacks were more likely than whites to have a gene that predisposed them to Kaposi sarcoma, a frequently observed symptom of AIDS. There has been no substantiation of this claim. In another case, it was alleged that the gene Gc1F is associated with differences in sensitivity to HIV infection. Several follow-up studies failed to replicate this result [Duh p. 3, Grmek p. 16, 196].

A "natural experiment" of sorts was observed in Trinidad in 1983 and the result suggests that Blacks seem to be genetically predisposed to developing AIDS once infected with HIV. In this case the incidence of AIDS among homosexuals infected with HIV was considerably greater among Blacks than among mestizo, white and Indian victims [Grmek p. 196]. It is not clear whether Blacks have a predisposing gene or whether the other groups have a protective gene. In any case, there are no scientific studies of this phenomenon.

Increasingly the microbes are evolving new strains that are unaffected by anti-biotics. There is no real defense against viruses like influenza and it is only a matter of time before there is another deadly, world-wide epidemic like the one in 1918-9 that killed 500,000 Americans. Then there is AIDS, Ebola, and Hantuvirus for which there are no cures. Diseases, a true curse of civilization, have at best, been held in abeyance. As long as humans choose to live in densely settled areas that trade with each other they will be plagued by microbes.

Politics, Economics and Ecology

"If all scientists have access to the same data," why queries University of Maryland physicist Robert Parks, "you might wonder is there so much passionate disagreement." [New York Times Op-Ed, May 2, 1998]. "What separates the two sides, he avers, "may not be so much an argument over scientific facts, scientific laws, or even scientific method, but profoundly different political and religious views." "When uncertainty abounds," he concludes, "scientific judgement has a way of conforming to the religious and political views of the scientist." Park, as far as he goes is surely correct, but his Op-Ed piece hints at forces more sinister than unconscious predilections inculcated at Mother's knee. He is well aware that those that are predisposed to be skeptical of the gravity of environmental

problems are well-financed by the "interests" such as oil, chemical, mining, ranching, timber, power, automobile and other industrial corporations that stand to lose a great deal should society adopt a more precautionary stance toward the by-products of their activities.

In their Pulitzer Prize winning account of the Watergate Affair journalists Woodward and Bernstein reported how their informant, the now infamous "deepthroat," told them that to find the answers to their questions, they should "follow the money." In this case, by following the path of large, illegal cash donations to CREEP (the Committee to Re-Elect the President), they would find the connection between the White House and the Watergate burglary. They did, and they found that the burglary at Watergate, and any number of "dirty tricks" played on Democrats during the 1972 presidential campaign, were ordered, and financed, by the Nixon White House. The efficacy of the "follow the money" strategy, unfortunately, is just as high should one wish to investigate in many other venues. In particular, as we have just seen above, in the realm of the "scientific debates" that surround environmental policy, knowing who is financing the "science" is critical. The scientific method is a most powerful force for finding the truth, but it has all too often succumbed to venality of its practitioners, who sometimes fake results, or work to distort, misinform or otherwise obfuscate the debate, all for the simple reason that it pays well.

We have demonstrated that there exists some controversy as to how concerned one ought to be about the "environmental crisis." The scientific knowledge we have examined is far from decisive on the issues. The lack of delimitation produced by scientific uncertainty leaves a great deal of political "wiggle-room." At the root of the issue is the fact that changes in the economic and social order directed toward correcting the putative ecological problems will prove costly. The contended ecological benefits of a CFC-free environment come at the expense of unambiguous costs. The same applies to reductions of CO_2 , SO_2 , CH_4 , PCBs and other substances believed to be dangerous in one way or another. Many feel that the benefits produced are not worth the costs. More specifically, the costs are certain, but the benefits are shrouded by scientific controversy and the resultant uncertainty.

In science the basic idea is to subject a hypothesis to a contest with the facts. Hopefully, one will always accept the hypothesis that is true and reject those that are false. Unfortunately, statistical tests are not that powerful in teasing out the true signal from the random noise. Sometimes, for example, to use an actual case, a cluster of data points that suggest an epidemic of leukemia has broken out in the neighborhood near electric power lines may simply be the result of random factors. The unwary then assert that electro-magnetic fields cause leukemia when in fact no such relationship exists. Consequently, a great deal of money may be spent to move people and/or power lines. Litigation, turmoil, and angst proliferate the lives of thousands of people. What appears to be an obvious cause-effect relationship may not withstand the statistical scrutiny of an epidemiological study. Before scientists will accept a cluster or correlation it must be shown to have a very small chance (five percent or less) of having been produced by chance.[112]

On the other hand, one could reject a hypothesis that is indeed true. Epidemiological studies of Love Canal rejected the hypothesis that cancer rates were any higher there than in other

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[112] Imagine the following situation. You are dealt a hand of poker. The five cards are all hearts. Is this chance or is the dealer cheating? How many times on 100 deals of the cards will you get 5 hearts. If the answer is more than 5 the hypothesis of cheating must be rejected.

communities. The cluster at Love Canal was asserted to be the result of random forces. In other, words such clusters appeared in many other locations were there were no toxic waste dumps.

An actual case involving lead poisoning is illustrative here. A young black girl was found to be severely lead poisoned, having a serum lead reading some seven times greater than the CDC-defined "safe level. The girl's IQ was measured at 75 - quite a bit below the population average of 100. Since there is some epidemiological evidence that lead poisoning can reduce IQ, the family sued the landlord for damages. During the trial, an expert witness, a highly regarded psychologist, testified that one could not, within the bounds of scientific proof, claim that the lead poisoning caused the diminished IQ of the young black girl. There was she argued, a reasonably good chance that the low IQ of the child could be the result of other factors. Since the average black IQ is not 100, but 85, the child's IQ was not that much below average. A series of random selections of girls from the black population will produce a child with an IQ of 75 about 40% of the time! To satisfy statistical criteria, this likelihood must be below 5% and sometimes 1% depending on how rigorous a test is desired. To satisfy science the girl's IQ would have had to have been below forty.[113] What this means is that there are many "intervening variables" such as poverty, poor quality home care, low quality urban schools, malnutrition and many others that are highly correlated both with low IQ and with being black. Lead poisoning is just one among many factors that could account for the diminished IQ of the unfortunate girl.

The point is, that outside of the most elaborately and perfectly controlled experiments with no random variables, there is only probable certainty in science - never absolute certainty. Every decision involves the risk of being wrong in one way or the other (false positive, or negative). Thus, there is no absolute proof that skin cancer rates are rising because of ozone depletion, or that anthropogenic factors are driving up global temperatures, or that PCBs cause cancer or dioxin causes a higher incidence of testicular cancer or lesbianism simply because nothing is known with absolute certainty. In matters of litigation and policy we have to deal with the "preponderance of the evidence" and that is a very slippery, ambiguous and subjective matter that allows "cognitive dissonance" to run wild. [114]

An individual's overall political ideology can predispose them to see ambiguous evidence in certain ways. It is less than coincidental that the individuals who stress this uncertainty and are reluctant to act on environmental issues are politically conservative, that is, they believe, to quote Thomas Jefferson, that the "government that governs the least, governs best." Conservatives, as a general rule, believe that government intervention produces more harm than good, and environmental regulation is no exception. Moreover, it is less the coincidental that this line of argument is always used by industries subject to environmental or health regulations e.g. the tobacco industry which claims there is no "scientific" proof that smoking causes cancer and which also views government regulation of smoking to be an infringement of individual rights.

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[113] This is an educated guess. We need to know the "standard deviation" of black IQ scores to estimate this score. The IQ distribution is standardized on white scores so we really do not know the standard deviation of black scores.

[114]Cognitive dissonance happens when people sift through evidence, but allow their predispositions from whatever source, to weight the evidence in ways that affirm their predispositions.

Others feel that unless radical changes are initiated immediately the human species may be doomed; there is no uncertainty and no cost that is too high. In the radical mind, uncertainty means risk and the stakes are simply to high to take the risks. Also, for many radicals the issue is a moral one, one of principle and no compromise will be tolerated when the heath of the people is put at risk, however small. The people are entitled to a pollutant-free environment. Indeed, pollution is viewed as merely a form of exploitation of the masses or women or a racial minorities by powerful corporations, males or whites. In virtually every instance, the radical ecological ideas are attached to a radical political agenda such as Anarchism, Socialism or Feminism.

Anarchists propose restructuring the economy on a smaller scale. In the Anarchist's utopia people would live in small, self-sufficient communities. The global corporations that dominate production and politics would disappear. Economies and communities would persist on a much smaller scale. Rather than control by rapacious, absentee-owned corporations, resources would be under the control of the people who lived in the community, who would in turn be more concerned with the quality of the environment and social justice. Mahatma Gandhi espoused such an ideal when he defended the Indian Village against the intrusion of British Capitalism. Such an ideal is also at the heart of the bio-regional concept - the structuring of communities along ecological rather than political boundaries.

Eco-socialists lay the environmental crisis at the feet of the capitalist system. Like the anarchists the socialists blame the rapacious profit-seeking corporation for environmental destruction. Neither the exploitation of labor or "nature" can stand in the way of the profit imperative. The government cannot help as it is captured by the very corporations doing the environmental damage. At the root of the issue is private control over resources, or the global commons (air, water, land, minerals, energy). Under socialism, it is claimed, resources will be controlled for the public interest rather than for private profit.

Eco-feminists see the exploitation of "nature" as simply another aspect of the domination mentality characteristic of patriarchal culture. Eco-feminists claim that patriarchy is based on domination and death. Under patriarchy men exploit each other, women and the natural world. Feminists, on the other hand are life-affirming and egalitarian and have a respect for all life, not just human life. In the Eco-feminist world there would be no hierarchy, and respect for all life forms would put to an end the patriarchal destruction the natural world.

The most radical proposal, from the so-called "deep ecologists," insists that the human population be reduced to one billion from the present level of five billion. While most are largely humane and seek benign ways to reduce the human population over time, some "deep ecologists" consider humanity to be a "cancer" on the earth and look favorably on the AIDS epidemic and other catastrophes that reduce the destruction of "nature" caused by humans.

In between sit those oriented toward trade-offs; those who contend that while some policies are needed to remove the most egregious ecological problems, there are many that are not "worth" correcting. Less ground-level O_3 would be nice, but how much will it cost to reduce it? What will the benefits actually be? In each case, benefits must be balanced against costs. The mind set of the latter group is characteristic of mainstream, liberal economists.

While Mainstream economists are consciously amoral, they are generally not consciously or explicitly political. Most economists accept that markets are fallible and government intervention is sometimes necessary. Nevertheless, economists reflexively take the institutions of capitalism as a given and attempt to devise policies that will make it work better - they are technicians. It is

generally presumed, despite problems such as externalities (pollution) and other minor "imperfections," that Capitalism is the best economic system yet devised. More specifically, most economists would argue, in particular, only capitalism can produce the economic growth necessary to make a clean environment affordable.

Walter Heller, chairman of the President John Kennedy's Council of Economic Advisors, once said that "he could not conceive a successful economy without growth."

> We need expansion to fulfil our nation's aspirations. In a fully employed, high growth economy you have a better chance to free public and private resources to fight the battle of land, air, water and noise pollution than in a low growth economy.

The Cornucopians - What Crisis?

In 1980 *The Global Report to the President*, produced a truly frightening prognosis of the human condition in the year 2000:

> If present trends continue, the world in 2000 will be more crowded, more polluted, less stable ecologically, and more vulnerable to disruption than the world we live in now. Serious stresses involving population, resources, and environment are clearly visible ahead. Despite greater material output, the world people will be poorer in many ways than they are today [Simon and Kahn p. 1].

Julian Simon and Herman Kahn produced a 583 page rejoinder to the Global 2000 Report that exemplifies the Cornucopian perspective. It should be noted from the outset that this book was financed by the ultra-conservative Heritage Foundation: an organization with the same goals and financing as the Cato foundation. Hence, one can expect that those sponsored by this foundation have certain values and scientific biases.

The "Cornucopians" argue that by the year 2000 "the world will be less crowded, less polluted, more stable ecologically and less vulnerable to resource-supply disruption than the world we live in now."[Simon and Kahn p. 1]. In the 583 pages of their rejoinder volume Simon and Kahn produce evidence that intends to replace the pessimism of Global 2000 with a more optimistic outlook. They enumerate 17 "facts" to justify their optimism including:

1/Life expectancy has been rising throughout the world;
2/The birth rate in less-developed countries has been falling;
3/Food supply has been increasing since WWII;
4/There is no statistical evidence for rapid loss of species;
5/The fish catch is rising;
6/Deforestation is troubling in some areas, but it is not a world problem;
8/ Rates of U.S. soil erosion are declining;
10/ Water scarcity does not pose a problem;
11/ The climate does not show signs of unusual and threatening changes;
12/ Mineral resources are becoming less scarce;
13/ There is no reason to believe oil prices will rise;

14/ Nuclear power is no more expensive than coal and cheaper than oil;
15/ Nuclear power cost fewer lives than energy produced with coal or oil;
16/ Solar energy is too dilute to meet humankind's energy needs;
17/ Threats of air and water pollution have been vastly overblown.

Simon and Kahn do not pretend there are no problems in the world future - all, they allow, will not be "rosy." The world has problems now and they will not be solved by 2000, but they insist, the world situation is improving not deteriorating.

After plowing through 583 pages one is left with the impression that the Global 2000 report was based on shaky data and should be considered accordingly. And what ever truth there was in these points, at present most of these assertions have proven overly optimistic. For example, the global fish catch peaked in 1989 and has been falling ever since. There is now virtually indisputable evidence of climate change, species extinction, and disaster levels of global deforestation. At the same time, one could present more data in support of a "Malthusian" view that makes the Cornucopian case seem weaker -- the global population continues to grow at alarming rates, and most of thie sgrowth is in the poor nations of the world.

One "neutral" reviewer found the debate between Cornucopians and Malthusians (optimists vs. pessimists) "exasperating." There are "so many empirical points at which battle can be joined that clear victory for either side is unlikely [Dryzek p. 15]. Moreover, our understanding of ecological systems is so imperfect we don't know which questions to ask, or what data to gather to determine if there is a crisis. Even with more and better data empirical evidence will not be decisive:

> Empirical evidence is impotent here because an improving trend in a single indicator may result from nothing more than the export of difficulties to a problem area for which a different indicator is appropriate [Dryzek p.18].

In short, a problem may appear solved in one form, but will appear in another place (spatial displacement), to another form of pollution (medium displacement) or it may appear in the future (displacement to the future).

For example, we solve the problem of air pollution by using nuclear power to produce electricity. The hazards of the nuclear wastes are postponed to the future.

Or, consider the water pollution that results from dumping "process water" from U.S. Steel Coking plant at Clariton Pa. The process water contained several toxic substances. U.S. Steel solved this problem by using the process water to "quench" (cool) the coke. The toxic substances were now released into the air - thus water pollution is displaced to air pollution. Finding that solution unsatisfactory the town allowed U.S. Steel to dump the water into town sewers, for a fee. The town then removes the toxic substances in the sewage treatment process. The town now has piles of toxic sludge, but knows of no way to safely dispose of it.

The classic case of spatial displacement occurs in the Midwest - Ohio. Electric utilities burn coal to produce electricity. When coal is burned sulfur dioxide and nitrous oxides are released into the air through giant smokestacks. The giant smokestacks were constructed to prevent *local* air pollution. Simon and Kahn found SO_2 emissions were falling because their data included only urban areas. When released at high altitudes the SO_2 drifts away from urban areas and falls on rural areas, forests and eastern cities as acid rain. Although not indicated in Simon's data, the problem has not

been solved; it has merely been displaced [Dryzek pps.16-20].

The Global Ecological Crisis

In the land of the blind....?

There are apparently very few people in the United States who would not agree that there is an ecological crisis that poses a substantial and immediate danger to the quantity and quality of human life on earth. There is very little agreement about what to do about it. For example, in 1989 a Time/CBS poll found that 80% of Americans agreed that "protecting the environment is so important that requirements and standards cannot be too high, and continuing environmental improvements must be made regardless of costs." [Merchant 1992 p.18]. In 1997, a New York Times Poll revealed that 47% of people would be willing to "invest in new appliances and insulation to cut household emissions of greenhouse gasses" and 65% agreed that the "US should take steps now to cut emissions of greenhouse gasses" regardless of what other countries do. The Times concluded that "Americans strongly favor environmental protection despite its costs" even should these costs include "lost jobs in their community." The method favored by most people was government imposed energy-efficiency standards (like those imposed in Sweden and Germany) [NYT, 11/28/97]. In short, the vast majority of Americans seem to agree with European "greens" that as a nation we should adopt the "precautionary principle." One can be sure that this group of affirmative, environmentally sensitive, responders did not include many economists, who consider such ideas "softheaded." [Blinder 1986].

Economists and environmentalists do not get along. As Lester Thurow put it "no two fighting cocks have ever disliked each other more." Indeed, even when sympathetic to the environmental cause, "they can barely sit in the same room." According to Thurow, economists and environmentalists are less likely to sign a peace treaty than Israel and her Arab neighbors" [Thurow 1992 p. 220, 222]. The root of the problem is the willingness of economists to, in some cases, subordinate environmental quality, to consumer goods and services, and as Stephen Schneider has noted, "most conventional economists [think] that society is independent of nature. In their opinion, most natural services associated with current climate can be substituted with relatively little harm to the economy"[Schneider, Laboratory Earth, p.142]. Ecologists, not so politely disagree, noting that "natural ecosystem services such as genetic diversity to provide food plants, wetlands for filtering wastes, or forests for flood control and maintaining the proper level of greenhouse gasses...are not substitutable at any practical price" [Schneider, Laboratory Earth, p. 143]. In an exchange with Stephen Schneider, William Nordhaus, a Yale economist, quipped that, "those who know the most about the economy are optimistic," to which Schneider replied, "those who know the most about the environment are worried" [Schneider, Laboratory Earth, p. 142]. Environmentalists, like Schneider, contend that "society shouldn't just bank on the stereotypical faith of economists that we'll somehow find an affordable substitute for each crisis and buy our way out of global scale disturbances, just as we often have before at smaller scales."[Laboratory Earth, p. 143]. The economist retorts that while surely there will be costs incurred from climate change in the future, but by allowing the economy to continue to grow future generations will inherit greater wealth to cope with them.

On the other side of the equation, economists contend that environmentalists simply do

not comprehend their position and really need a dose of Economics 101. One of the leading undergraduate Public Finance texts suggests that the reason why the government uses the "command and control approach" advocated by environmentalists, rather than the "market-based" approach [emission taxes or tradeable permit schemes] advocated by economists, is that they simply do not understand economics. The text quotes Alan Blinder:

> An interview survey of sixty-three environmentalists, congressional staffers, and industry lobbyists - all of whom were intimately involved in environmental policy - found that not one could explain why economists claim that pollution can be reduced a t lower cost by emission fees [i.e. a tax on pollution] than by direct controls. Not one! This lack of knowledge, however, was not inhibiting; many of those surveyed opposed the idea anyway" [quoted in Browning and Browning, Public Finance and the Price System 4th edition, p. 57]

Of course, this argument is somewhat dated, Blinder asked these questions in the mid-1980s. It is true that environmentalists abhorred selling the "right to pollute" in the marketplace. But since then, many have changed their tune. The 1995 Acid Rain Program which uses a tradeable permit system was supported by most environmentalists. Indeed, most environmentalists see some kind of emissions trading system as integral to global efforts to control carbon-dioxide emissions. While it is surely true that a radical fringe holds to the anti-market mentality, it is not longer true of the environmental movement at large. Nevertheless, the economists that wrote this text could not pass the chance to call environmentalists stupid, or, perhaps, merely ignorant.

To economists, environmental quality is simply another commodity, the optimal (read efficient) quantity of which depends on the relation between its social benefits and its "price" (social costs). Economist Lester Thurow on the cost and benefits of electricity:

> Every conceivable technique for producing electricity produces waste and every conceivable technique kills people, but the benefits that flow from electricity are worth it [Thurow 1992 p. 222].

Or consider the case of lead poisoning of children. In 1978 the United States banned lead use in paint and lead additives in gasoline. But, these policies were not very costly. Now, tens of thousands of poor children are still being poisoned by lead in paint applied before the ban and from lead soaked urban dirt that is the result of years of the use of lead anti-knock compounds in gasoline. Let us be clear about this. Americans know that several hundred thousand young children, mostly poor and black, are harmed by lead exposure every year. They also know that the harm can be diminished by removal of lead paint from old rental housing. It is not done because the people who own these rental properties find the cost of lead removal too high to be consistent with profitability. The state does not force them to do it as they would simply abandon the property and then the poor would have nowhere to live. The long and the short of it is no one wants to pay to remove the lead hazard; apparently the private cost is not justified by the social benefit. Actually, however, a benefit cost study done by the Center for Disease Control indicated a program of lead paint removal would produce more benefits than costs. The political problem

is that the benefits are received primarily by a pariah group - poor Black and Hispanic children and the costs would fall on the predominantly white middle-class taxpayer. When the landlord reckons it, he pays the cost and gets no benefits. The State should figure the external benefits that accrue from not harming children. These external benefits the CDC has shown exceed the private costs. If the State orders the landlord to pay he goes bankrupt and they State may end up owning the property. The only solution is to have the State (taxpayer) pay for the cleanup, but this is an expensive and therefore unlikely option.

Economists are our society's professional cynics who, according to Oscar Wilde, "know the price of everything and the value of nothing." Thus, an economist would ask, "are Americans really ready to pay $30[115] for a pound of steak so as to avoid the environmental costs associated with large scale cattle production, say, of burning the Costa Rican rainforest to produce pasture, or to give up fast-food hamburgers altogether?" Probably not! H.L. Mencken, more acerbic than even 100 economists, would side with the Economists on this one, as he opined "no one ever lost money underestimating the intelligence of the American people." The economists appear to be right on this one. When push comes to shove, most Americans (and virtually everyone else) will, when faced with a loss of jobs resulting from the protection of endangered species, or higher prices of food grown organically, or lower profits due to meaningful water pollution standards, or higher taxes on gas and electricity to protect the air we breath, or the cost of lead paint removal to protect our children, blanche at the cost and set environmental concerns on the back burner or even better into a dark, dusty corner (Rapa Nui Complex?). At the very least, despite wehat they say in the polls, there is no evidence that Americans would be willing to pay *any* price for environmental protection.

Perhaps, rather than lack of intelligence, it is human nature that is the problem. The great economist A.C. Pigou complained that people tend to have a "defective telescopic faculty" which was his way of saying people do not worry about the future as much as they should. The Ehrlichs contend that we humans focus on the short-term for evolutionary reasons:

> People aren't scared because they evolve biologically and culturally to respond to short-term "fires" and to tune out long-term "trends" over which they have no control. Only iof we do what does not come naturally - if we determinantly focus on what seems to be gradual or nearly imperceptible changes - can the outlines of our predicament be perceived clearly enough to be frightening [quoted in Schneider, Laboratory Earth, p. 146].

The well established historical pattern of humans destroying their environments, what one

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[115] It has been estimated that beef production use 3000 gallons of water per pound of beef produced. Water is sold to beef producers at subsidized rates. If beef producers had to pay fair market value for water a pound of beef would cost $30.00 to produce.

anthropologist has called the human record of "rape and ruin," has led socio-biologist E.O. Wilson to wonder whether human beings were, genetically, so selfish and short-sighted as to be, as a species, suicidal. Surely, one of the main obstacles to the remediation necessary to slow climate change, is that the benefits are far in the future and the costs are in the present. The cost-benefit method economists use to evaluate climate change, builds in a bias against the future. As the benefits occur in the distant future, the practice of discounting tends to reduce them to trivial size compared to the costs, most of which are incurred in the present.

Alternatively, the problem may be that most people are having enough trouble surviving in the present and thus they have neither the time nor the energy nor the power to do anything about environmental degradation. As economist Alan Blinder says, people want only the environmental amenities they can afford. They most certainly do not want the marginal economic security they have threatened by "bunny huggers," environmental terrorists and a bunch of rich people who like to hike in the "wilderness." One economist quipped that the environmental movement forces a trade-off between the interests of people and those of penguins. Those with deeper sensibilities, perhaps an *accoutrement* of affluence, can live with this trade-off, others literally cannot. Environmental issues are politically divisive as the costs of protecting the environment are not spread evenly, nor are the burdens of environmental degradation spread fairly across the population. Hence, protection of nature is far from a "common cause."

So how do we explain the poll results? Two students of environmental issues suggest the following:

> Like some aspects of welfare, the environment is increasingly considered to be an entitlement rather than something that must be paid for by sacrifice. When people say that the environment must be protected at all costs, either they are expressing something akin to religious fanaticism, or they feel the cost will be borne by someone else [Bloch & Lyons p. 24].

...the one-eyed man is King!

If one is to assess one's opinion on ecological matters one must be careful to understand one's own ideological agenda and how it may be shaping your evaluation of the available evidence. One must also be aware of the ideological biases of those producing the evidence. One must proceed with both eyes open. Otherwise, the one-eyed man, the one who knows his own agenda in a world where others do not do their homework, will indeed rule.

The one-eyed man is unscrupulous. He will cast his argument to appeal at many levels: ignorance, fear, racial and other prejudices, political bias and so on. For example, the seriousness of the objective environmental problem is minimized based on bogus "evidence," and *ad hominem* attacks are leveled at environmentalists. There are many who feel that environmentalists are alarmists who are pushing our society into expensive solutions to environmental non-problems or pose solutions to real problems that are needlessly expensive compared to the benefits. In short, from this perspective, we are victims of an "Ecoscam."

Ronald Bailey compares environmentalists with "millenarian" crackpots:

> Soothsayers once sought the portents of doom in the livers of sheep, in the flight of geese across the sky and in patterns of juggled bones. Modern seers examine the entrails of equations, measure molecules in the air, or conjure with computer models looking for signs of impending apocalypse [Bailey 1993 p. 1]

In *Apocalypse Not*, Block and Lyons, libertarian critics of environmentalism, opine that the Green Movement is made up of:

> nomadic bands of witches, anti-nuclear activists, Celtic nationalists, sun worshipers, and discontented people of all stripes [p. 22]

According to Bailey, the underlying motivations of these doomsayers are many. Apocalyptics, according to Bailey desire to frighten people into accepting their egalitarian, anti-capitalist political agenda:

> Ecological alarmism...incorporates many aspects of Marxist theology, especially the idea that capitalist society is ultimately self-destructive. For many modern leftists the global environmental crisis is the new agent of history which will eventually destroy capitalism. In the new radical vision, capitalism, instead of strangling itself to death on its class contradictions, will choke itself to death on its own wastes. Radical environmentalists are now the earth's vanguard class who will lead the struggle to bury capitalism and Western materialism.[Bailey p.5-6]

Similarly, conservative economist Walter Williams refers to environmentalists as “watermelons” - green on the outside, but red on the inside. To Williams and other conservatives, the environmental movement is merely a surrogate for a collectivist desire for social control [Ben Bloch, Cato Journal 15(2-3),1994]. Other critics of environmentalism suggest similarities between environmentalists and Nazi's:

> Ecologism took firm root in Germany where it became a major element of the Third Reich, the first government to be dominated by radical environmentalists. The oak leaf as symbol of the Nazi SS, the motto of "Blood and Soil," the possible need to sacrifice mankind to nature, the fixation with tree planting, the state control of natural resources and many other familiar ecological themes were present in Hitler's Germany [Bloch & Lyons p. 21-22][116]

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[116] Bloch & Lyons are representing the ideas of Anna Bramwell as presented in her book Ecology in the 20th Century: a History,Yale, 1989.

and that the Green movement is going to produce the same results as the Nazi's:

> the radical green movement advocates self-sufficient, often communal economic zones that would be prohibited from exchanging goods with other zones...a very large fraction of the five billion or so persons on Earth simply cannot survive without the technology and trade that exists today. A world run by the radical Greens would result in mass extermination of human beings that would make the combined performance of Hitler, Stalin and Mao pale by comparison [Bloch & Lyons p. 22].[117]

Apocalyptics, Bailey opines more cynically, also need to provoke fear to win support either for budget growth of the various environmental bureaucracies (EPA, NOAA, NASA) or gaining individual research funding. As significant, is the need of environmental advocacy groups (actually they are bureaucrats also) to generate a crisis atmosphere to facilitate raising funds through donations. They need the money; the annual budgets of these groups is estimated to be in the neighborhood of 250 million dollars [Bloch & Lyons p. 22]

It is true that many environmental programs put forward to address environmental problems do involve radical restructuring of the economy in an egalitarian direction and worldwide redistribution of wealth. It is also true that NASA announced "the hole in the ozone problem" just about at the time its budget was under consideration. It is also true that a number of careers have been made by the prediction of one type of apocalypse or another, none of which has occurred. *But these facts per se do not rule out the possibility that the crisis is real.* Greenhouse critics such as Richard Lindzen correctly emphasize that GCMs fail to resolve a number of significant uncertainties. Through some twisted logic, Lindzen and others like him, deduce that this uncertainty means there is no climate change problem. This is simply not valid reasoning.

During the 1980s, scientists modeled the depletion of the ozone layer. When the scientists actually measured the depletion of the ozone layer, they found it was far worse than the models had predicted. As Dr. Michael McElroy, Chairman of the department of Earth and Planetary Sciences at Harvard, reminded Dr. Lindzen at a conference at Tufts University, “just because a situation is uncertain does not imply that the underlying reality is benign.” [quoted in Gelbspan, p. 31]. Logically, one simply cannot use uncertainty to dismiss a problem, the uncertainty cuts both ways.

Obviously, there is a real empirical problem here, that is to say, a significant gap in our knowledge. The "alarmists" say we have to act now to curtail population growth, CFC emissions

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[117] Bloch & Lyons report Bramwell here. See note 4. The characterization of Greens applies to Anarchist Social Ecologists and the so-called Bioregional Movement. While they do not explicitly endorse any political agenda the Deep Ecologists would no doubt approve of the implied economic restructuring. None would advocate, however, a transition to such a new world that would endanger billions of lives.

(ozone depletion), CO_2 emissions (greenhouse gases), acid rain (SO_2, NO_2), nuclear power and genetic engineering (biotech). Bailey and others says the evidence is at best ambiguous so we should investigate these phenomena further, that is, "look before we leap" into very expensive programs that fundamentally alter the way we live, not to mention very radical restructuring of the social order.

Bailey, as noted earlier, is optimistic about the ability of the human race to rationally attack the various pollution problems we actually face:

> This book [Ecoscam] demonstrates the reality of human progress, and I hope it will thereby help restore the next generation's belief in its future. I do not counsel mindless boosterism or Panglossian optimism. The world faces some real problems, but those problems do not portend the end of the world. And Yes, there are sometimes unintended consequences to human actions [emphasis added]. However, human history shows that our energy and creativity will surmount what ever difficulties we encounter...there is nothing we cannot handle.[xii]

Bailey is especially critical of the media which seems to latch on to the utterance of any quack if they think it will sell papers. He urges media people to be more careful. For example, they should talk with other scientists to validate the claims of the alarmists. The media, he avers, should be concerned when they observe a high degree of moral fervor and high levels of righteous indignation and demands that something should be done *now* or calamity will follow. Finally, he urges the media to investigate whether "the proposed program [is] clearly identified with any particular political ideology, party or interest group" [Bailey 177-78]. For example, what might one glean from Mr. Bailey's association with, and openly expressed admiration for, the Cato institute, a free market oriented, corporate-funded think tank with a very clear, conservative political agenda?

Bailey is quite correct in asserting that the more apocalyptic environmentalists have a political agenda. Anarchists, Socialists, and Feminists are busy developing new philosophical constructs that incorporate ecology. The common factor in these new philosophies is that maintenance of the status quo - capitalism -is fundamentally incompatible with personal liberty and freedom, the liberation of women and minorities, social justice, biodiversity and the maintenance of an ecosphere that can sustain human life. Therefore, to protect humans and other species from extinction, these new philosophies uniformly agree that capitalism must go. The nature of the new social order varies with the agenda of the particular group one examines.

But, it is equally important to understand that maintenance of the status quo is also a political agenda. Those National, Class, Race and Gender groups that benefit from the current arrangements naturally want to conserve them. Mr. Bailey is being quite disingenuous when he discards the "apocalyptics" because they have a political agenda. Every position on an environmental issue has an explicit or implicit political agenda.

In a way, the world-view of the party imposed itself most successfully on the people

incapable of understanding it. They could be made to accept the most flagrant violations of reality, because they never fully grasped the enormity of what was demanded of them, and were not sufficiently interested in public events to notice what was happening. By lack of understanding, they remained sane. They simply swallowed everything, and what they swallowed did them no harm, because it left no residue behind, just like a grain of corn will pass undigested though the body of a bird - George Orwell, 1984

Edward Bernays is the 'father" of the modern public relations industry. One of his more notable PR coups was a campaign which he created for the American Tobacco Company in 1929. The purpose of the campaign was to promote smoking among women which at that time was deemed unfeminine and socially taboo. Benays' plan was to associate smoking with women's liberation. "At his instigation," reports Sheldon Rampton and John Stauber, "ten New York debutantes marched in the Sunday Easter Parade, defiantly smoking cigarettes as a protest against women equality." As hundreds of newspaper editorials condemned these brazen women, "women began lighting up in droves." [Rampton & Stauber (2001), p. 19].

Bernays was one of the first practitioners of the public relations strategy known as the "third party technique" or "putting your words in someone else's mouth." This strategy is far more effective than advertising or direct statements by the interested party. Who, after all, would lend any credence to assertions from a tobacco company to the effect that the health hazards of smoking have been exaggerated. Similarly, should tobacco companies openly campaign for "tort reform" that would impose severe limits on the ability of juries to award damages plaintiffs and even on people right to litigate, their words would be seen as little more than an expression of self-interest. It is much better to "camouflage" the vested interest behind the words of an "independent authority," e.g. an expert, a foundation or institute, or a leader of some sort. It is surely true, as Bernays himself noted, that "no man, in today's complicated world, can base his judgements and acts entirely on his own examination of the evidence" [quoted in Rampton & Stauber, p. 18]. People thus seek various trusted authorities to help them sort through complex issues. Seemingly independent "institutes" or experts can be a powerful propaganda voice for corporate interests.

In 1998, the government investigation of Microsoft's alleged anti-trust violations surely worried the software giant. Microsoft hired a large PR firm, Edelman Public Relations Worldwide to attempt to "head-off" the antitrust investigations. Edelman proposed multimillion dollar media campaign that would give the appearance of a "groundswell of public support for the company. This would be achieved by hiring freelance writers to write opinion pieces, letters to the editor etc. for submission to newspapers. When the details of the campaign was leaked to the press, Microsoft denied it s existence, but when confronted with copies of the proposal, it merely remained silent and endured several weeks of embarrassment as the computer industry pressed vented in endless editorials [Rampton and Stauber p. 8-9].

About a year later and "Open Letter to President Clinton" signed by 240 economists appeared as a paid advertisement in the Washington Post and the New York Times. The ad urged Clinton to drop the antitrust investigation of Microsoft. The economist claimed that Microsoft

was being persecuted by its competitors and consumers would lose if Microsoft were prosecuted. Economists from many prestigious Universities signed the petition. The advertisement was paid for by the Independent Institute, and outfit than had been fighting the Antitrust Laws for about a decade. All of this seems above board, there are legitimate issues involved here. It is always difficult to determine whether a firm has achieved market dominance by illegal means or simply by being better than its rivals. The complicated and ultimately abandoned prosecution against IBM is the case in point. But, the point here is different.

The advertisement cited a well -reviewed book, published by the Independent Institute and written by two of its fellows Stan Liebowitz and Stephen Margolis. Some critics claimed the book was a "brazenly partisan argument for Microsoft." The question is then, "just how independent a third party was the Independent Institute. Microsoft was indeed a supporter of the institute, but the Institute would not comment on how much more than the $1,000 annual dues paid by the other 2000 members, Microsoft may have contributed. A New York Times reporter, based on leaked documents, revealed that Microsoft contributed 20% of the Institutes operating funds. Indeed, further investigation revealed that Microsoft had paid part of the expense of publishing the book, and paid the full $153,868.67 it cost to run the paid advertisement [Rampton and Stauber p. 10].

It is certainly absurd to beleive that Leibowitz and Margolis manufactured their book at the behest of Microsoft or that the Independent Institute is merely a hired propagandist. Nor can one reject their arguments just because they happen be in the interest of Microsoft. But "at the same time, something is clearly wrong with this situation. It is naive to imagine that conservative think tanks aren't extremely beholden to their funders in the business world or to corporate leaders and their boards. This is simply the way the power of the purse works. Just as politicians cannot ignore the demands of major donors if they want to survive, neither can institutions ignore their benefactors."[Rampton and Stauber p. 11].

Not so hidden agendas

There are several industries with a great deal to lose should concern over global warming wax into real policy changes. Emissions of CO_2 when fossil fuels are burned for whatever purpose are the primary alleged cause of global warming. Serious actions on global warming would require dramatic reductions in the use of fossil fuels. Not surprisingly then the industry has an interest in controlling information regarding global warming. A partisan of the global warming cause wrote in a recent issue of Harper's:

> Capital keeps it nose to the wind. The people who run the world's oil and coal companies know that the march of science, and of political action, may be slowed by disinformation [Gelbspan p.33].

The article goes on to report that an organization called *The Global Climate Coalition*, is little more than a front for a public relations operation for the oil, coal and other industries threatened by emissions controls.

> Since the first Earth Day in 1970, two generations of American children have been taught to believe that we are running out of everything--energy, water, minerals--and that humans are "killing the earth." Young people in America today are largely ignorant of the role that human ingenuity, creativity, technology and the free market play in solving the planet''s environmental problems. In America''s classrooms, children are taught that the only way to solve environmental problems is with top-down, command-and-control government regulation. Instead of inspiring our children to become scientists, inventors and engineers who confront and solve our environmental problems, our schools are busy teaching them to become politicians, bureaucrats, lobbyists and regulators.
>
> The Center for Environmental Education Research believes this one-sided approach produces distorted and dangerous perspectives and encourages public policies that threaten our democracy and free enterprise economy--the best guarantors of human dignity and a clean environment. These distorted ideas about man and the environment are taught in America''s schools--most noticeably through environmental education curricula.Research studies conducted by the Center have reviewed more than 200 environmental books and curriculum materials, including best selling textbooks, used in K-12 grades. These studies found that the vast majority of materials teach that our forefathers plundered and raped the environment for personal greed. These books and materials also state that we have cut down our forests, slaughtered our wild animals and polluted our streams and air. Students are taught that their future holds nothing, but epidemics of skin cancer from ozone depletion and mass starvation due to overpopulation. Worse, these books present such claims as fact, not opinion, and offer little supporting proof. Rarely do the books mention that distinguished scientists often disagree with the claims of imminent catastrophe. Seldom, do they acknowledge that the science and economics surrounding environmental issues are often uncertain and open to continual discovery. Thus, most environmental education in America today presents students with misleading and one-sided information--rather than teaching children about the complex and often disputed science of such issues as air pollution, endangered species and global warming. **From the Web page of the Competitive Enterprise Institute March 30, 2001.**

After, the "brutally hot" summer of 1988, Dr. James Hansen, of NASA's Goddard Institute of Space Studies, testified before Congress of his concern that emissions of greenhouse gasses consequent to human industrial activities were causing a detectable and growing impact on climate [Hampton & Stauber p. 267]. A short time later, the Global Climate Coalition was established. The GCC was not, however, a public interest group formed to fight for emissions controls, it was, rather formed by a coalition of PR firms, which, in turn, were funded by a number of powerful corporations who were opposed to any policy that might force emissions reductions. Among the PR firms engaged in the formation of the coalition was the E. Bruce Harrison Company, a company that, two decades earlier led the smear campaign against Rachel

> In 1996, Robert Balling testified that "there's absolutely no warming in the Arctic. This is quite troubling when this is the part of the planet where we think we should see the greatest amount of warming at the present time." In fact, "the evidence directly contradicts Balling's testimony." Scientists have documented an increase in Alaskan soil temperature of 2-5C and a warming of the deep layer of the Arctic Ocean. NOAA reports an increase in of about 9F over the last thirty years a nine stations north of the Arctic Circle. Thus, the warming pattern has been just as the model predicted - Ross Gelbspan, The Heat is On, p. 74-75.

Carson and her book *The Silent Spring* [Rampton & Stauber p. 270].

The Chairman of the GCC was an executive of the American Petroleum Institute. The GCC operated out of office of the National Association of Manufacturers. Included in its membership were the American Automobile Manufactuers Association, Amoco, the American Forest &Paper Association, American Petroleum Institue, Chevron, Chrysler, the U.S. Chamber of Commerce, Dow Chemical, Exxon, Ford, GM, Mobil, Shell, Texaco, Union Carbide, and some 40 other corporations and trade associations [Rampton & Stauber p. 270]. Since 1994, the GCC has spent more than $63 million in its effort to discredit the notion, posited by Dr. Hansen in 1988, that industrial activity has, and will continue to cause climate change. In addition, some of the members, such as The National Coal Association, have spent additional money toward the same purpose. The National Coal Association spent $700,000 in 1992 and 1993 [Gelbspan p. 33]. In 1993, the American Petroleum Institute gave the Barston-Marsteller PR firm $1.8 million to mount a campaign against the taxation of fossil fuels [Rampton & Stauber p. 271].

The year 1991 saw the formation of another PR creation known as the Information Council for the Environment. The goal of this organization, in its own words, was to "reposition global warming as theory (not fact)" [quoted in Rampton & Stauber p. 272]. The Scientific Advisory Panel of the ICE was constituted by Patrick Michaels from the Department of Environmental Services at the University of Virginia, Dr. Robert Balling of Arizona State University, Sherwood Idso of the US Water Conservation Laboratory, and last, S. Fred Singer, professor emeritus of environmental sciences at the University of Virginia. The basic strategy of the ICE was to "directly attack the proponents of global warming" by making them appear to be like so many other crackpots who have held false beliefs (e.g., the earth is flat) and like "chicken-little, have erroneously warned of "gloom and doom" The media releases (radio ads, advertisements, interviews) were to be aimed at "less educated men" and "lower income women" that typically relied on such media for all of their information. Fortunately, some rather damaging ICE memos were leaked to the press. "An embarrassed Michaels, "citing...blatant dishonesty" departed the ICE. Nevertheless, Michaels, a senior fellow at the Cato Institute, continues as a critic of global warming and collects some substantial consulting fees and grants from coal companies such as the Western Fuels Association and the German Coal Association [Rampton & Stauber p. 273].

Much of this money, is spent funding the activities of global warming critics who are skeptical of the corpus of scientific evidence sustaining the climate change hypothesis. For example, a recent volume [1995] edited by Ronald Bailey which just crossed my desk is titled, *The True State of the Planet*. The book, published by the Free Press, is a "project of the Competitive Enterprise Institute" [see box] and was funded by the John T. Ohlin Foundation. The Olin Foundation supports many conservative think tanks including the Cato Institution. The book claims to provide evidence that environmentalists have exaggerated the gravity of a number of environmental problems. The book is purported to contain the research reports of "Ten of the World's Premier Environmental Researchers." The article critical of the mainstream view on global warming, that is, the one that says it is a serious potential problem, is Robert Balling of Arizona State University. Balling considers the "greenhouse scare" to be based on interpretations

of the actual scientific evidence that are highly selective and "seriously flawed" [Balling 1995 p.85]. In effect, he contends, it is all “pure media hype” [quoted in Gelbspan, 1995, p. 39]. Balling projects warming, if any, of less than one degree centigrade, but in any case, the magnitude is so low and the science so “speculative it is useless to think about it”[quoted in Gelbspan, 1999, p. 39]. Indeed, Balling claims that if global warming were to happen it might produce benefits in excess of costs. He points, for example, to the possibility that higher nighttime temperature might reduce the chance of frost, and lengthen the growing season [Balling 1995 p. 100]. Balling’s book, *The Heated Debate*, was published by the Pacific Research Institute, a “free-market” think tank that is home to right-wing scholars from any number of fields, and is opposed to virtually all government regulation, from Affirmative Action to Environmental action.

Over the last six years Balling has received over $200,000 in funding from oil and coal interests in England and Germany. The German Coal mining Association gave him $80,000 and British Coal Corporation coughed up another $75,000. The Kuwait Foundation for the Advancement of Science also gave Balling a “grant” of $48,000. In total Balling has received about $300,000 from coal and oil interests [Gelbspan, 1999, p. 45]. This is not to say that Balling and others like him are academic whores. They may have arrived at their conclusions before they got the money. Whatever their motives or the correctness of their assertions [see box], the agenda of the industries supporting them are clear. It is also clear that the science produced by these "mavericks" get disproportionate representation in the public debate because they have so much money behind them. Moreover, these men have been instrumental as allies to conservative republicans, in fighting against government appropriations that would provide funds for climate research. In 1996, after hearing testimony from Balling, Lindzen and Micheals, the House Science Committee slashed the budgets of NOAA, NASA and the EPA in areas where money was used for climate research [Gelbspan p. 76].

In 1994, and 1995, the Global Climate Coalition spent one million dollars and nearly another million in 1996. The Global Climate Coalition which included the major automobile producers and companies and corporations in virtually every sector of U.S. business, agriculture and forestry, including electric utilities, railroads, transportation, manufacturing, small businesses, mining, oil, and coal. It is a platform for business and industry, both domestically and internationally, for lobbying Congress and watching over international climate change negotiations. It also closely monitors the activities of the Intergovernmental Panel on Climate Change (IPCC) and contributes to the IPCC's scientific assessment documents.

In 1992 and 1993, the National Coal Association, surely the biggest loser under emissions controls, spent $700,000 on the global warming issue [Gelbspan p. 57]. The American Petroleum Institute, a member of the GCC, spent on its own on “public relations” regarding the climate issue some $1.8 million in 1993 alone [Gelbspan, p. 56]. The combined expenditures of the five largest environmental groups totaled only $2.1 million [Gelbspan, p. 56]. But, the “environmentalists” do have more resources at their service. The U.S. government, of course, has been spending roughly $2 billion a year on publicizing the global warming problem and now proposes a new $6.3 billion package, which includes a set-aside for public education. In addition, Pew Charitable

Trust has pledged some $50 million over the next 10 years to promote this issue to the press and the public, largely through the National Environmental Trust and the Pew Center for Global Climate Change. The David and Lucille Packard Foundation just donated $1.5 million to train 60 "scientist-communicators" to work the press on global warming. Millions more have been donated by the W. Alton Jones Foundation and other foundations. The issue has been a major focus of the Sierra Club, the Natural Resources Defense Council, and dozens of other green activist organizations. On the industry side, approximately $13 million was spent on a nationwide ad campaign in the fall of 1997.

In 1998, the New York Times reported that a group of industry opponents of action against global warming had begun to organize a public relations campaign to discredit the "science" behind proposals to reduce emission of greenhouse gasses, most especially CO_2. The report was based on an eight page internal memo leaked to the New York Times by a "whistle-blower"[Rampton & Stauber p. 283]. The effort, led by the American Petroleum Institute and the major Oil Companies with the aid of several conservative policy research organizations has been bankrolled with $5 million. Prominently among the advocates of the plan are established skeptics such as Fred Singer, founder of the Science and Environment Policy Project, and Frederick Seitz, who once served as President of the National Academy of Science,[118] and who is now another prominent critic of the any plan to pare back CO_2 emissions. The plan is to spend $600,000 to "recruit" up to 20 "respected climate scientists" who are skeptical of the science used by the Intergovernmental Panel on Climate Change, a large group scientists which advises the UN on climate change, and which has warned of the threat posed by continued global warming [Rampton & Stauber p. 283]. According to a spokesman from the Petroleum Institute, these skeptics would be used "to inject credible science and scientific accountability into the global climate debate and thereby...undercutting the conventional [IPCC] wisdom." From the larger group, five scientists would be chosen and *trained* to participate in "media outreach, that is to be "a one-stop resource on climate science for members of Congress, the media..and all others concerned. " More important it is hoped that this public relations campaign will alter the public and the media's current perception of these skeptics as being "discredited apologists" for industry interests [NYT 4/26/98]. Just how scientists who have been recruited and trained by the Petroleum Institute can be "independent" enough, in any meaningful sense of word, to be seen as anything but industry "apologists" is not revealed.

Who are these guys?

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[118]Seitz recently wrote a letter to thousands of scientists urging them to sign a petition opposing the global climate change accord. Included with the letter was an article that looked very much like a reprint of an article published in Journal published by The National Academy of Science. The article pointed to the benefits of increased carbon loading in the atmosphere and dismissed the global warming threat. The article, however, had not been published by the Academy. Indeed the article, which presented itself as a peer-reviewed work, had not ever been published [Robert L. Park, NYT 4/2/98].

As Boston Globe journalist, Ross Gelbspan, put it in his book, *The Heat is On*, in the arena of the global warming debate, there is a contest going on for the "control of reality"[Gelbspan p. 33]. In his view, the battle is being won by corporate interests opposed to a proactive agenda on global warming. Because of financial resources that are "almost without limit," these interests can buy congress." Indeed, "even before the climate issue surfaced, they already had" [Gelbspan p. 33]. These interests also have virtually unlimited access to the media through which they can promote the views of about a "half-dozen" climate change skeptics, who while prominent scientists, have no special expertise in climate research, and indeed, all too often reveal their ignorance of the most fundamental aspects of climate science. Many of the vociferous naysayers tend to be astronomers, chemists, and physicists, often having no track record whatsoever in climatology and the environmental sciences. Having established their reputations, they have often joined forces with conservative think tanks such as the American Enterprise Institute, the Cato Institute and the Hoover Institute. Some such as Frederick Seitz, a physicist who served as President of the National Academy of Sciences and Thomas Gale Moore of the Hoover Institute, seem oblivious to the ongoing depredation of nature and the climate system. "The environmental problem is largely hypothetical and not substantiated by careful observations," Seitz wrote [Gale Christensen, a historian at Indiana State University, and author of *Greenhouse: The 200 year History of Global Warming,* Providence Journal, July 14, 1999].

Indeed few, if any, of the scientific papers of these skeptics have been placed in respected scientific journals, where all articles are subject to intense peer review. While about 95% of the literature referenced by the IPCC was published in peer reviewed journals, the skeptics publish their contrarian views in op-ed pages, letters to the editor, or in journals that they either edit themselves or are highly questionable in terms of the thoroughness of peer review process. For example, one of the leading climate change skeptics, Pat Michaels, an associate Professor of Climatology at the University of Virginia, edits a "journal" called the *World Climate Review*, that is fully funded (production and dissemination) by the Western Fuels Association [Gelbspan, p.39]. Moreover, one of his publications was in a putatively "refereed" journal called, *Technology, the Journal of the Franklin Institute*. As the article was received early in September of 1994, and accepted early the following month, the refereeing process could not have been very through [Dr. Benjamin Santer, lead author of the 1995 IPCC report, quoted in Gelbspan, p. 234].

In an appendix to *The Heat is On*, Gelbspan provides a compendium of the responses of leading climate scientists to the critiques of the skeptics. A list of some of the remarks is quite instructive. Regarding, the critique of Pat Michaels, it is noted that his work "simply does not pass muster scientifically." Michaels' analysis was seen as "seriously flawed" and it indicated a "poor understanding" of the climate literature, in short, "he missed the point." Thus, while his study was considered by the IPCC, it was seen as a "catalog of misrepresentation and misinterpretation" and "judged to be irrelevant." Another reviewer, claimed that Michaels' work revealed his ignorance or was a "deliberate misrepresentation" [Gelbspan, pp. 208-211].

Another prominent greenhouse skeptic is Dr. Fred Singer from the University of Virginia. Singer receives his funding from the "large oil interests" [ARCO, Exxon, Shell, Sun Oil, Unocal] and from the likes of Sung Young Moon, in whose paper, *The Washington Times*, he publishes regularly. The Moon organization has also published three of Singer's books [Gelbspan p. 46]. Singer was a vocal critic of the Montreal Protocol leading to the ban on CFCs. According to

Singer, the issue of the disappearing ozone layer was nothing more than a media scare, and he denounced the Nobel committee when it awarded the 1995 science prize to the three scientists who had discovered this problem. With regard to the critique of Dr. Fred Singer, that there is "no evidence of a current warming trend," it has been observed that he is "seriously out of touch with reality."[p. 234]. Indeed, Dr. Benjamin Santer, claims that Singer "seems to be viewing reality through some strange distortion filter." First, Singer's claim that there has been no increase in global temperature in the past fifty years is "not supported by the data." Singer also claims that the IPCC failed to reveal that there has been no upward trend in temperature over the past twenty five years, even though such information was evident in the studies on which the IPCC relied. The author of these studies has rebutted that the zero and negative trends observed over a few years, as noted by Singer, were not reported by the IPCC because there were not significant. Singer's basic problem, Benjamin Santer claims, is that he "does not understand the very basic concepts of signal and noise"[P. 235]. The human influence on global temperature over any short period of time (signal) is quite small compared to other climate forces (noise) and can be easily overwhelmed by them in any period of time. For example, the noise from a substantial volcanic eruption may mask the effects of slowly accumulating carbon-dioxide for several years. Trends in anthropogenic warming are only discernable only over long periods of time when with sufficient number of observations it can be teased out of the noise.

Of all of the critics, the most respectable, due to is position at MIT is Richard Lindzen. Lindzen claims that fears of a runaway greenhouse effect are unfounded. In 1991, Lindzen postulated a negative feedback system that would remove water vapor from the atmosphere as temperatures rise. Since water vapor is the most important greenhouse gas and tendency for temperature to rise would be inhibited. Unfortunately, while Lindzen's hypothesis was plausible, it was been contradicted by research done at Princeton University and Lindzen retracted it in 1995 [Gelbspan p. 49].

The politician that uses the "information" provided by these skeptics is Representative Dana Rohrabacher (R-CA, 45th) who happens to chair the House Science Committee. Rohrabacher has many interesting political causes. He opposed the granting of "most favored nation status" to China due to China's horrendous human rights abuses. He is also a supporter of a program (Employee Stock Ownership Plan) to increase the share of American companies owned by their employees. He has also been active in expanding patent rights for small inventors. ON the matter of climate change, however, the man is simply off the wall and since he has a great deal to say about the budget for climate change research, he is a formidable enemy. At the final meeting of the Science Committee in 1996, he commented that, "I think that money that goes into global warming research is really money down a rathole." [quoted in Gelbspan, the Heat is On, p. 77]. Three of the climate experts who had testified before this committee were Michaels, Balling and Lindzen. After the hearings, Rohrabacher concluded:

> The fact is that global warming, the more I have studied the issue, the more I have come to believe...that at best it's nonproven and at worst it's liberal claptrap. And in fact I have come to the conclusion more every day that it's more toward the latter than the former [quoted in Gelbspan, The Heat is On, p. 77]

The IPCC reports published in 1995 were "widely recognized to be uniquely valuable

reviews of current knowledge about climate change." Nevertheless, "some of the results and interpretations were questioned." In August of 1996 a workshop was organized to analyze IPCC report in some depth. The workshop produced a volume edited by Yale economist William Nordhaus, titled, Economics and Policy Issues and Climate Change. In his introduction, Nordhaus wrote:

> The basic science behind greenhouse warming is well established, and the basic projections represent mainstream science. There are vast uncertainties in the field, but these should no lead people to conclude that the issue can be ignored [p. 5].

Nordhaus continues:

> It must be tempting for a politician with a time horizon of at most a few years, or a business with a time horizon of at best a few decades, to ignore a problem so full of controversy, whose impact will truly not be felt for a century or more. It must be tempting to hope it will go away or that someone will find a fundamental flaw in the science. This approach is ill-advised [p. 5].

Surely Nordhaus is right as far as he goes, but he has not fully captured the problem of the professional skeptics, the politicians that align with them, and the people who own them. The latter people and businesses are acting, not out of genuine uncertainty, but strictly according to their economic interests.

By 1999, cracks began to appear in the united corporate front against policy interventions to avert climate change. In 1999, the GCC lost BP, Amoco, Shell, and Dow Chemical, all of whom now declared global warming an immediate problem. In 2000, Ford, Daimler-Chrysler, Texaco, and General Motors departed. The Du Pont Company announced that it would voluntarily reduce emissions by 35% by 2010 [Rampton & Stauber p. 287]. But, as of the summer of 2001 there is not law or international treaty addressing the problem of climate change.

Nor has the campaign to fight such polices diminished, only the tactics have changed. Now the "interests" recognize that emissions of greenhouse gasses may raise temperatures, but they contend that such temperature increases will be slight. Moreover, it is averred that the rising atmospheric load of carbon dioxide will be a salutary thing as it will promote plant growth. In any case, even should climate change prove infelicitous, it would still be too costly, in terms of profits and jobs, to prevent it. It will be better for society to absorb the damage rather than prevent it.

References

Bruce N. Ames & Lois Swirsky Gold [1995] The Causes and Prevention of Cancer, Ch. 5 in Ronald Bailey ed. *The True State of the Planet*, Free Press

Ronald Bailey [1993] *Ecoscam*, St. Martins

Ronald Bailey ed. [1995] *The True State of the Planet*, Free Press

John M. Blair [1976] *The Control of Oil*, Vintage

Robert Balling Jr. [1995] Global Warming; Messy Models, Decent Data and Pointless Policy, Ch 3 in Bailey ed. *The True State of the Planet*, Free Press.

Lester R. Brown et al [1996] *State of the World: A Worldwatch Institute Report on Progress Toward a Sustainable Society*, W. W. Norton

L. Susan Brown [1993] Anarchism, Existentialism, Feminism, *Society and Nature*, 2(1):117-136

William Cline [1992] *The Economics of Global Warming*, Institute for International Economics

Theo Colborn et al [1996] *Our Stolen Future*, Dutton Signet

Theo Colborn et al [1997] Chemical Impostors, *Sierra*, Jan/Feb.

Barry Commoner [1979] *The Politics of Energy*, Knopf

William J. Catton Jr.[1993] Carrying capacity and the death of a culture: A tale of two autopsies. Sociological Inquiry, 63(2):202-223.

Robert Cullen [1993] The True Cost of Coal, *Atlantic Monthly*,

Paula Di Perna [1985] *Cluster Mystery: Epidemic and the children of Woburn, Mass*. Mosby.

Devra Lee. Davis & H. Leon Bradlow [1995] Can Environmental Estrogen Cause Breast Cancer? *Scientific American*, October pp. 166-72].

Devra Lee Davis [2002] *When Smoke Ran Like Water,* Basic Books

Dudley Dillard [1967] *Economic Development of the North Atlantic Community*, Prentice-Hall

Wayland Drew [1995] Killing wilderness, in George Sessions (ed.) *Deep Ecology for the 21st Century*, Shambala

Stephen R. Edwards [1995] Conserving Biodiversity, in Bailey ed. *The True State of the Planet*, Free Press.

Paul and Anne Ehrlich [1994] *Healing the Planet*, Addison-Wesley

Barbra Epstein [1993] Ecofeminsim and grass-roots environmentalism in the U.S. in Richard Hoffricher (ed.), *Toxic Struggles*, New Society Publishers

Therese Feng [1999] *Controlling Air Pollution in China: Risk Valuation and the Definition of Environmental Policy,* Edwin Elgar

Ross Gelbspan [1997] *The Heat is On: The Climate Crisis*, Perseus Books

John Gribbin [1990] *Hothouse Earth: The Greenhouse Effect and Gaia,* Grove Widenfield

Thomas Gradel & Paul J. Crutzen [1995] *Atmosphere, Climate, Change*. Scientific American Library.

Marvin Harris [1977] *Cannibals and Kings*, Vintage

Chaia Heller [1993] Toward a radical ecofeminism, in *Society and Nature*, 2(1):72-96

Ulricke Heider [1994] *Anarchism: Left, Right and Green*, City Lights

E.K. Hunt [1995] *Property and Prophets* 7th ed., Harper Collins

Del Ivan Janik [1995] Environmental Consciousness in Modern Literature, in George Sessions (ed.) *Deep Ecology for the 21st Century*, Shambala.

Stanley J. Kabala [1991] *Current History*, November.

Charles J. Krebs [1978] *Ecology: The Experimental Analysis of Distribution and Abundance*, Harper & Row

Dolores LaChapelle [1995] Ritual- the pattern that connects in George Sessions (ed.) *Deep Ecology*, Shambala

Richard Levins and Ricard Lewontin [1985] *The Dialectical Biologist*, Harvard

Jon R. Louma [1991] Gazing into Our Greenhouse Future, *Audubon,* march

Andrew McLaughlin [1995] The Heart of Deep Ecology in George Sessions (ed.) *Deep Ecology*, Shambala

William McNeill [1963] *The Rise of the West*, Chicago

William Mc Neill [1978] *Plagues and Peoples*, Anchor

Robert Mendelsohn, William Nordhaus, and Daigee Shaw [1994]. The Impact of Global Warming on Agricuture: A Ricardian Analysis, *The American Economic Review*, September:753-771.

Carolyn Merchant [1992] *Radical Ecology*, Routledge

Richard Monastersky [1997] The Big Chill: Does Dust Drive Earth's Ice Ages?, *Science News* V152 (Oct. 4.)

E. Meszaros [1981] *Atmospheric Chemistry: Fundamental Aspects*, Elsevier

William D. Nordhaus [1993] Reflections on the economics of global climate change, *Journal of Economic Perspectives*, 7(4):11-26.

Sandra Postel [1996] *Dividing the Waters*, World Watch paper 132.

Yngve Ramstad and James L. Starkey [1995] The Racial Views of John R. Commons in *Research in the History of Economic Thought and Methodology*, (13):1-79, Warren Samuels and Jeff Biddle eds., JAI Press

Sheldon Rampton and Peter Stauber [2001] *Trust Us, We're Experts: How Industry Manipulates Science and Gambles with Your Future*, Tarcher/Putnam.

Barbra Rogers [1980] *The Domestication of Women*, Tavistock Publications

Andrew Revkin [1994] *The Burning Season*, Plume

Stephen Schneider [1996] *Laboratory Earth: The Planetary Gamble We Can't Afford to Lose*, Weidenfeld & Nicholson

Stephen Schneider [1989] *Global Warming*, Sierra Club Books

Joni Seager [1993] *Earth Follies*, Routlege

Julian Simon and Herman Kahn [1984] *The Resourceful Earth,* Blackwell

Richard Peto [1984] Why Cancer? Ch 19 in Julian Simon and Herman Kahn [1984] *The Resourceful Earth,* Blackwell

Jack Turner [1995] Gary Snyder and the practice of the wild, In George Sessions (ed.) *Deep Ecology for the 21st Century*, Shambala.

Stephen Viederman [1993] Sustainable Development: What is it and how do we get there? *Current History* (April) 180-85

World Resources Group [1995] *World Resources: A Guide to the Global Environment* 1994-95, Oxford

Eric Wolf [1982] *Europe and the People Without History*, U. California Press