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A Review of "Development and Global Environmental Change

by

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Development and Global Environmental Change

William U. Chandler

OVERVIEW

Chandler capsulizes the arguments supporting a policy of "sustainable development" in light of global environmental changes. That is, he advocates development activities which satisfy both economic and conservation criteria. The author discusses three major forces associated with economic development which shape global environmental change — energy use, tropical deforestation, and health and population growth. Six priorities arise:

1. Energy efficiency can be imporved worldwide
2. Infant mortality can be cut to Chinese levels throughout the developing world
3. Population growth rates can be dramatically reduced by coupling family planning services with primary health care
4. Small-scale agriculture can be significantly improved with decentralized incentives and financing
5. Deforestation can be halted and fuelwood needs satisfied
6. Nations can cooperate to begin controlling industrial gas emmissions and other specific threats to global climate

Arguments leading to these conclusions are presented in the paper. But, Chandler states, Americans must reduce their inefficiency, waste, and pollution if efforts to eliminate them elsewhere in the world are to succeed.

For the lay reader, Chandler includes a section (Global Environmental Change) on the processes of atmospheric change and the relationships between deforestation and development. (On the atmosphere: "If Earth were an apple, the atmosphere would be no thicker than the peel.") He also discusses in some detail the inter-relationship between Environment, Disease, and Population Growth. (pp. 4-17).

HIGHLIGHTS OF PAPER

Development for Conservation

Conservation requires setting limits on certain activities. Development policy itself can be fashioned to push back these limits by making resource use more efficient. Development for conservation will require three actions: 1) pricing natural resources to reflect both their replacement costs and their environmental impacts; 2) developing conservation criteria which set limits on consumption that do not exceed sustainable yields or destroy the natural resource base of the global economy; 3) satisfying health and family planning needs by reducing environmental sources of disease (i.e. recognizing that satisfying basic human needs is a prerequisite to sustainable development).

Efficient Energy Use. This is the most important climate concern. The world has barely cut into the potential for cost-effective energy conservation. Chandler states:

> "By slowly adopting existing measures — technology for 50 mpg cars,...high efficiency motors — the world could cut the energy intensity of the global economy in half over the next 35 years. Slow energy growth would permit a shift of energy use per capita from the developed to the developing world without sacrificing living standards or development potential. Indeed, progress in development may be impossible otherwise.

Chandler discusses comercial energy consumption, using steel manufacturing as an example. Two strategies for change energy-wasting behavior to energy-conserving behavior are presented: energy price incraeases and regulatory policies (pp. 23-24).

Efficient Agriculture. Efficiency is essential to sustainability. In China, the decentralization of agriculture and the shift to market incentives increased ouput and efficiency. In the West, farm production subsidies have undermined resource efficiency, though Chandler acknowledges the political motivations of these distortions.

Healthy Populations. The United States may offer unique capabilities for vaccine development. However, commercial firms are naturally more likely to sponsor research for drugs with lucrative markets. "Thus, the diseases of affluence take precedence over the diseases of poverty." Publicly-funded research could take up this "worthy effort."

Conclusion

"The U.S., like all nations, now has an environmental stake in the development policies of all other nations. [I]t will be forced to consider environmental impacts in its selection of projects...and shift efforts to make develoment 'sustainable'. These efforts must include assistance in structural reforms designed to reduce simultaneously economic and resource waste."

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I. Introduction

Human activities have reached a scale capable of altering the biosphere, a fact that places new demands on development policy. Signs of global environmental change have already become evident, particularly in the atmosphere. An unexpected "hole" found in the earth's ozone layer may portend a global ozone reduction that would expose all life to dangerous levels of ultraviolet radiation. Greenhouse gases such as carbon dioxide rapidly accumulating in the atmosphere threaten to warm the earth's climate, and thus flood coastal cities and shift rainfall patterns. Acid rain carried by winds across international boundaries has damaged large areas of forest in western Europe. Global environmental change may, as these problems indicate, undo decades of material progress and deny development to many of the planet's five billion people.[1]

The emergence of global environmental change adds urgency to appeals for "sustainable development." Sustainable development will require integrating environment and development policy, meaning that activities formerly guided

by purely economic criteria will now have to satisfy conservation criteria as well. Economic criteria traditionally represent efficiency and require only that investments be good ones in terms of present value. Development can be sustainable, however, only if investments are good and do not undermine the environmental foundations of economies.

At least three major forces associated with economic development shape global environmental change: 1) energy use; 2) tropical deforestation; 3) and health and population growth. Energy use directly embodies the conflict between environment and development. Energy sustains modern societies. It not only reduces drudgery and makes inhospitable climates habitable, it substitutes for scarce resources. Energy permits the replacement of copper with aluminum, wood with iron, iron with ceramics, and so on. It is absolutely essential for industry, for transportation, in short, for development. But energy use more than any human activity exacerbates the carbon-dioxide greenhouse problem, acid rain, and so on. Energy productivity for economic growth will thus be a priority in any scenario of sustainable development.

Tropical deforestation also represents a stark conflict. Logging, agricultural expansion, and urban growth contribute to the destruction of forests. Deforestation undermines development by destroying watersheds, reducing fuel and material availability, destroying species, and affecting global climate.

All environmental problems are driven fundamentally by population growth. Each of the 86 million people added to the population each year will consume

additional energy, driving up carbon dioxide emissions. Each of these persons will require metals, wood, and chemicals, thus increasing pressure on energy supplies (for making steel and aluminum), forests (for supplying wood), and environmental sinks (which must absorb the toxic wastes of industrial processes). Many of these persons will be unable to find farmland and will thus push out onto marginal land, increasing soil erosion and deforestation rates.

But population growth is, in a sense, a symptom of underdevelopment. Its causes include not only lack of family planning services, but also the parental desire to have children to help with the hard work of development, to provide for parents in their old age, and to assure that a minimum number of children survive. Environmental diseases due to underdevelopment dramatically increase the numbers of children who fail to survive.

The decade ahead in development policy offers an irretrievable opportunity to ameliorate these problems, to integrate economic and environmental policy. Beyond that time, environmental stresses may cause disruptive climatic surprises and economic discontinuities. The reconsideration of development priorities requires a vision of goals that satisfy growing human needs while protecting the biosphere. And it requires a theory of change, a clear concept of how policies affect human behavior and natural resources.

II. Global Environmental Change

II.a. Atmospheric Change

If Earth were an apple, the atmosphere would be no thicker than the peel; the bulk of gases forming Earth's climate and sustaining life is only 36 kilometers deep.[2] This thinness makes it vulnerable to human pollution, and in ways scientists do not fully understand.

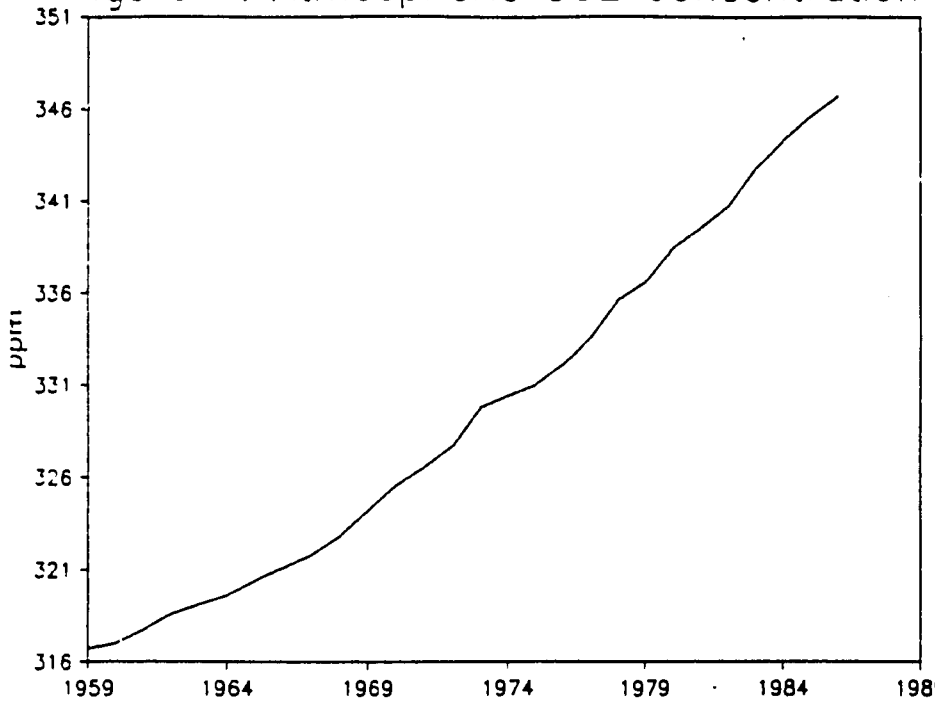
If the ozone layer of the atmosphere were condensed to a liquid, it would be no deeper than the sole of a shoe. Yet, it is vital to life on earth because it protects plants and animals from destructive ultra-violet radiation. An ozone "hole" over Antarctica has intensified scientific concern because no one knows how it formed. October ozone levels over Antarctica have been reduced by about 50 percent over the last two decades.[3] This "hole," a reduced concentration of ozone gas, appears each October and lasts for a month. Some scientists suspect that chlorine from chlorofluorocarbons (CFCs)--used in refrigerators and aerosol cans--destroys the ozone, with other pollutants such as nitrogen compounds from auto exhaust or fertilizer use also contributing to its breakdown.[4] The recent discovery that winter ozone concentrations have been reduced by 2.3 to 6.2 percent over mid-latititudes has intensified concern that human activities may be capable of causing rapid changes in global climate.[5] U.S. Environmental Protection Agency analysts have projected 800,000 additional cancer deaths in the United States alone over the next 88 years as

a consequence of ozone destruction.[6] Costly crop damage would also arise from increased ultraviolet light intensity.

Air emissions such as carbon dioxide may affect development by affecting the global climate.[7] The National Research Council (NRC) has concluded that human-induced climate change is a likely prospect over the next century.[8] The earth's atmosphere, NRC estimates, will warm by 1.5 to 4.5 degrees Celcius (C), disrupting rainfall patterns and raising sea levels. The effect on low-lying nations such as Bangladesh and the Netherlands could be catastrophic. Agriculture will be forced to make expensive adjustments in irrigation and plant varieties, adjustments which will be much more difficult in developing nations. Large development projects may have their useful lives cut short. The question is no longer whether humans will alter the earth's climate, but by how much. Development policies will in part determine the answer to this question.

Gaseous emissions from both agriculture and energy use exacerbate the greenhouse effect, but carbon dioxide is the most important trace gas. This by-product of fossil fuel combustion is accumulating rapidly in the atmosphere, where it absorbs reflected light and emits infrared radiation back toward the ground thus warming the atmosphere. Fossil fuel combustion produces over 5 billion tons of carbon emissions per year, half of which remain in the atmosphere. Since 1960, the global concentration of carbon dioxide gas has increased from 316 parts per million (ppm) to about 345 ppm.[9] (See Figure 1.) Most climatologists expect rapid climatic change to commence within the next two decades.[10]

Figure 1: Atmospheric CO2 Concentration



SOURCE: Scripps Inst. of Oceanography

Evidence is also mounting that non-CO_2 greenhouse gases such as methane may cause atmospheric change equal in magnitude to that projected for carbon dioxide.[11] (See Table 1.) CFCs and other chemicals that interact to destroy ozone also contribute to the "greenhouse" effect, the warming of the earth's atmosphere. Accumulating methane, for example, could seriously destablize atmospheric chemistry because it neutralizes the main mechanism available for removing human pollutants. Technically speaking, methane destroys hydroxyl radicals that would otherwise remove nitrous oxide, acid-rain-causing sulfur and nitrogen compounds, and unburned hydrocarbons. Methane is produced in anaerobic processes, including the decay of submerged material in rice paddies and the digestion of food in the stomachs of ruminants.

How the Third World develops will vitally affect emission rates for CFCs, carbon dioxide, and other greenhouse gases--and thus people everywhere. It is sometimes assumed that because the developed world consumes most of the world's resources, it should therefore be the focus of efficiency efforts. But while the developing world can justifiably lay claim to a greater share of resources, it does not follow that the carbon dioxide problem, for example, is a problem only for developed nations. The developing world--excluding China--now adds as much carbon dioxide to the atmosphere as Western Europe. (See Figure 2.) To the extent that development increases wealth, it will--without a conscious effort--increase demand for activities that produce carbon and other trace gas emissions and thus compound the global climate change problem. Moreover, the curves of emissions are still sharply rising in the developing

Table 1: Anthropogenic Gases and the Greenhouse Effect

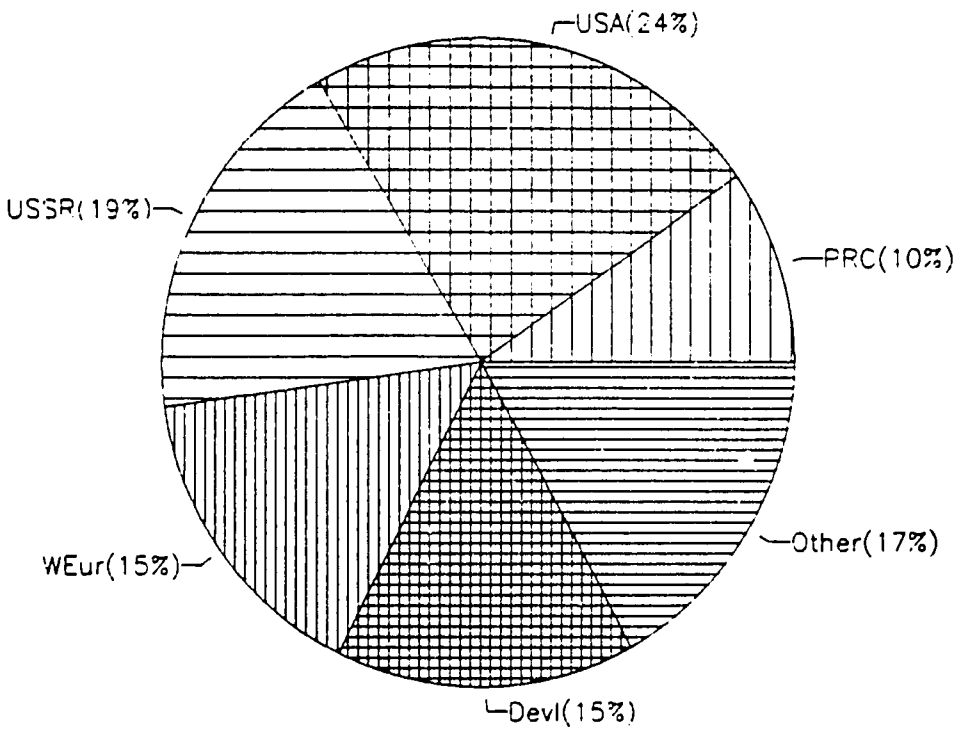
Constituent	Estimated Current Rate of Increase (% yr^{-1})	Effect of Doubling on Temperature (Degrees Celcius)	Residence Time in Atmosphere (years)
Carbon Dioxide	0.2-2.3	0.5	2[a]
Carbon Monoxide	0	1-2[b]	3
Tropospheric Ozone	0.9-1.1	(c)	na
Nitrous Oxide	0.3-1.1	0.2	150
CFC-11	0.1	5.0	75
CFC-12	0.02	5.0	110
Methane	0.3-1.4	1.0	7-11

a. This may be misleading because CO_2 is part of a natural cycle.
b. One source reports "no trend" in CO accumulation.
c. Measures of total column ozone indicate a depletion rate ranging from - 0.2 to - 5.0 percent per year, with most reduction coming in the stratosphere.

SOURCES: Jae Edmonds and Gregg Marland, "The Energy Connection to Global Climate Change: Gaseous Emissions," Institute for Energy Analysis, 1986, mimeo; NASA, "Present State of Knowledge of the Upper Atmosphere," 1986; and T.F. Malone and J.G. Roederer, eds., Global Change (London: Cambridge University Press and the International Council of Scientific Unions, 1985).

FIGURE 2: Fossil-Energy Carbon Emissions, 1986

SOURCE: R. Rotty, w/ UN data



world, though they have declined in the United States and Western Europe. (See Figure 3.)

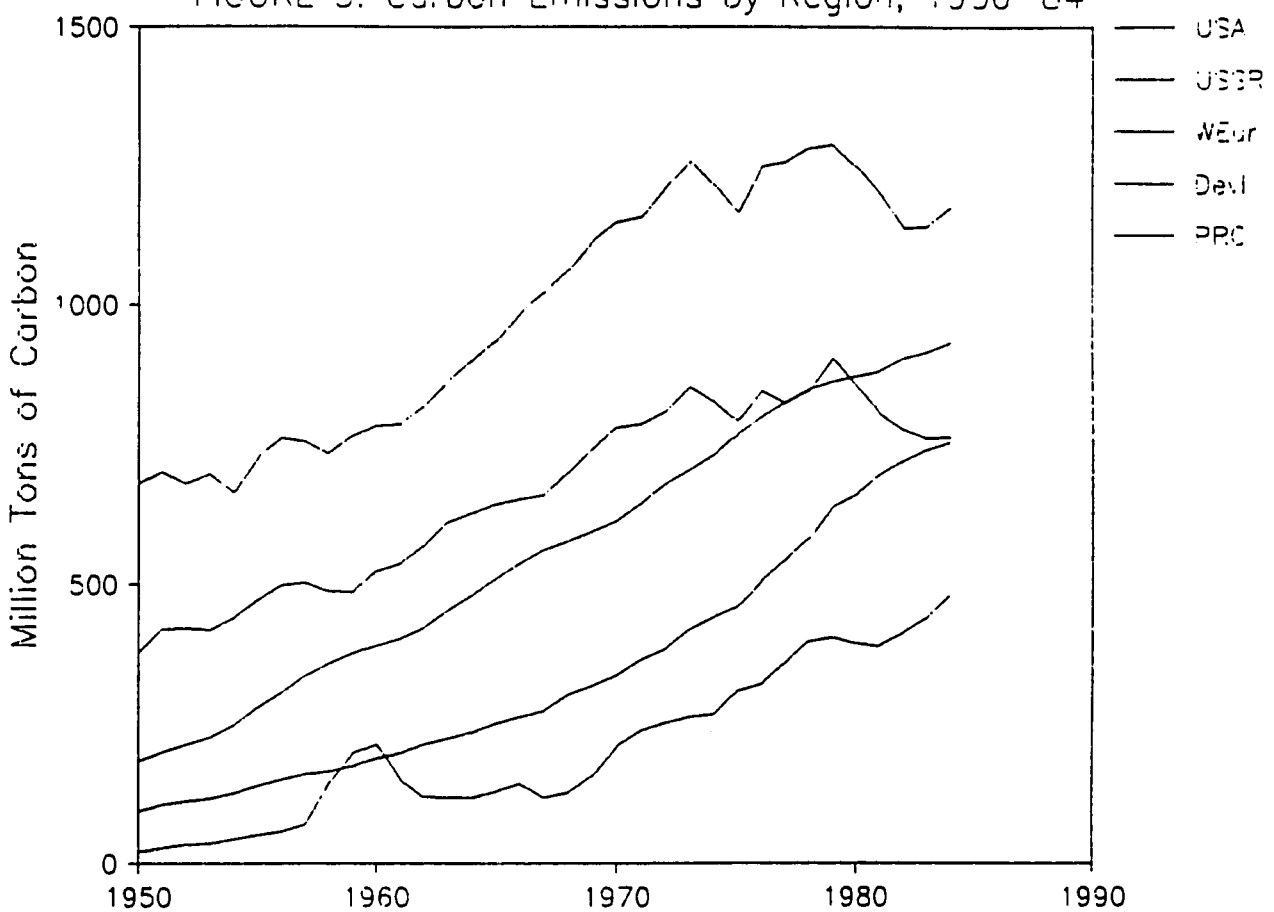
Development, on the other hand, could bring environmental benefits. Investments in capital equipment could make the economies of developing countries more energy efficient and therefore more environmentally benign. Investments in agriculture could make land more productive per hectare, thereby limiting the climatic impacts of rapidly expanding land use and deforestation. Such reductions in resource use intensity per unit of economic output will increase the potential for sustainable development.

II.b. Deforestation and Development

Tropical deforestation raises global concerns. Forest cutting annually injects 1-2.6 billion tons of carbon into the atmosphere, equal to one-fifth that contributed by fossil fuel combustion.[12] Moreover, as rain forests disappear, so too will many plant and animal species. Their loss may have implications for all countries because half of all pharmaceuticals were discovered in nature, including curare, quinine, and reserpine.[13]

Forest cutting and other land-use changes arise with growing demand for food and fiber, lumber, land for cities, and firewood for fuel.[14] Globally, forests are being destroyed at a rate of about 0.6 percent per year, but high reforestation rates in the developed world mask very high rates of deforestation in the developing countries. (See Table 2.) Tropical forest cutting occurs at rates higher than 3 percent per year in Costa Rica, Nepal,

FIGURE 3: Carbon Emissions by Region, 1950–84



SOURCE: R. Rotty, w/ UN data

Table 2: Annual Deforestation Rates, by Region, 1981-85

Region	Area (hectares)	Rate (percent)
Tropical America	5,611,000	0.63
Tropical Africa	3,676,000	0.52
Tropical Asia	2,016,000	0.60

SOURCE: World Resources Institute and the International Institute for Environment and Development, World Resources Report, 1986 (New York: Basic Books, 1986).

Table 3: Populations Affected by Fuelwood Shortages by Region, 1980 and 2000

	1980	1980	2000
Region	Acute Scarcity	Deficit (millions)	Deficit
Africa	49	131	175
Asia	39	288	239
Latin America	9	152	50

SOURCE: World Resources Institute and International Institute for Environment and Development, World Resources Report, 1986 (New York: Basic Books, 1986).

Nigeria, Ivory Coast, and Paraguay. And though the percentages are lower, tens and even hundreds of millions of hectares are cut each year in Brazil, India, Indonesia, Papua New Guinea, Peru, and elsewhere.[15] The ratio of forest cutting to replacement is 5 to 1 in Asia, 10 to 1 in South America, and 20 to 1 in Africa. The area of rainforest will, at these rates, be reduced by 12 percent by the end of the century.[16]

Deforestation and related land-use changes also promote soil erosion (which reduces land productivity), reduce water supply, increase flooding, and may affect local climatic conditions. They reduce the availability of fuelwood supplies and building materials. Fuelwood shortages, in particular, reduce development productivity by requiring long, time-consuming treks for firewood, and by making hygienic cooking and washing difficult. Hundreds of millions of persons are already affected by the fuelwood crisis. (See Table 3, above.) The crisis diminishes both land and labor productivity, and in turn diminishes development potential.

Another major forest problem is energy-related acid rain, which in some areas has extensively damaged forests, causing economic as well as environmental damage. In the Federal Republic of Germany, for example, over half of all forest area has been seriously affected by acid rain, and Waldsterben, or forest death, has become a household word.[17] Because coal resources are plentiful in many countries, including China, acid rain may undercut other development goals. Reforestation efforts to enhance wood and fuel supplies could be defeated by acid-rain induced damage to young trees.

The inherent complexity of the earth system daunts attempts to understand it. Yet the risks of failing to act on global change are high. As George Woodwell, Director of the Woods Hole Research Center, has said:

> The issue is unquestionably one of the most urgent topics for the agenda of the councils of nations. It strikes at the core of the question of the continued habitability of the Earth at the very moment that the human population is passing 5 billion on its unplanned and uncontrolled upward path. It has a potential for disruption of the human enterprise over a few decades that rivals the chaos of war.[18]

III. Environment, Disease, and Population Growth

The main causes of early death in the developing world are environmental diseases, although they may not often be categorized as such. This fact, and the higher priority that analysts and observers sometimes place on other environmental problems, recalls the aphorism that "The most common form of human stupidity is forgetting what one is trying to accomplish."[19] Because the goal of development is to improve the lot of people, special attention must be paid to early death and sickness.

Indeed, satisfying basic needs may be a prerequisite for solving that most fundamental environmental problem, population growth. High infant mortality directly contributes to high population growth rates. Parents who desire a certain number of children--perhaps for labor or security in old age--tend to have "extra" children in order to assure survival of the desired family size. Infant mortality reductions increase parental confidence that

the desired number will survive despite their having smaller families. This behavioral change directly reduces the birth rate.

In addition, childhood and tropical diseases such as malaria and schistosomiasis hinder the hard work of development by sapping the energy and health of children and adults alike. Afflicted women, especially, have less energy for agricultural work, and so incomes and nutrition levels may be reduced. Similarly, sick children have less energy for learning, and so may be stunted intellectually as well as physically.

Altogether, preventable diseases kill some 17 million children worldwide each year, causing a full third of all annual mortality. Ninety-eight percent of these deaths, moreover, occur in Third World countries.[20] Childhood disease each year kills as many people as would a limited nuclear war. But unlike nuclear war, this annual toll is certain to occur--unless development intervenes.

Health problems can be ranked for priority by comparing the magnitude and risk of their consequences. Using this guide, the number one priority for world health would be diarrhea. (See Table 4). This humble disease is the largest single cause of premature death--death before age 65--in the world, claiming the lives of some 5 million each year.[21] Simple measles kills half as many. Tropical diseases take more than a million lives each year and make hundreds of millions sick. (See Table 5.)

Table 4: Neglected Causes of Premature Death

Cause	Deaths per Year (millions)	Share of Total (percent)
Diarrhea	5	10
Pneumonia	4	8
Low Birth Weight	3	6
Measles	2	4
Smoking	2	4
Malaria	1	2

Sources: World Health Organization; UNICEF; and William U. Chandler, Banishing Tobacco (Washington: Worldwatch Institute, 1986).

Table 5: Tropical Diseases and Their Consequences

Disease	Persons Afflicted (millions)	Deaths per Year
Malaria	300	> 1
Elephantiasis[a]	270	na
Leishmaniasis	200	na
Schistosomiasis	200	.5 - 1.0[b]
Intestinal Parasites	1,000	-

a. All Filariasis infection. b. Estimated for late 1970s.

Sources: World Health Organization data bank; Tineke Boddé, "Biotechnology in the Thi·· World," BioScience, October 1982; U.S. Congress Office of Technology ssessment, Status of Biomedical Research and Related Technology for Tropical Diseases (Washington: U.S. Government Printing Office, 1985); and William U. Chandler, Improving World Health: A Least-Cost Strategy (Washington: Worldwatch Institute, 1984).

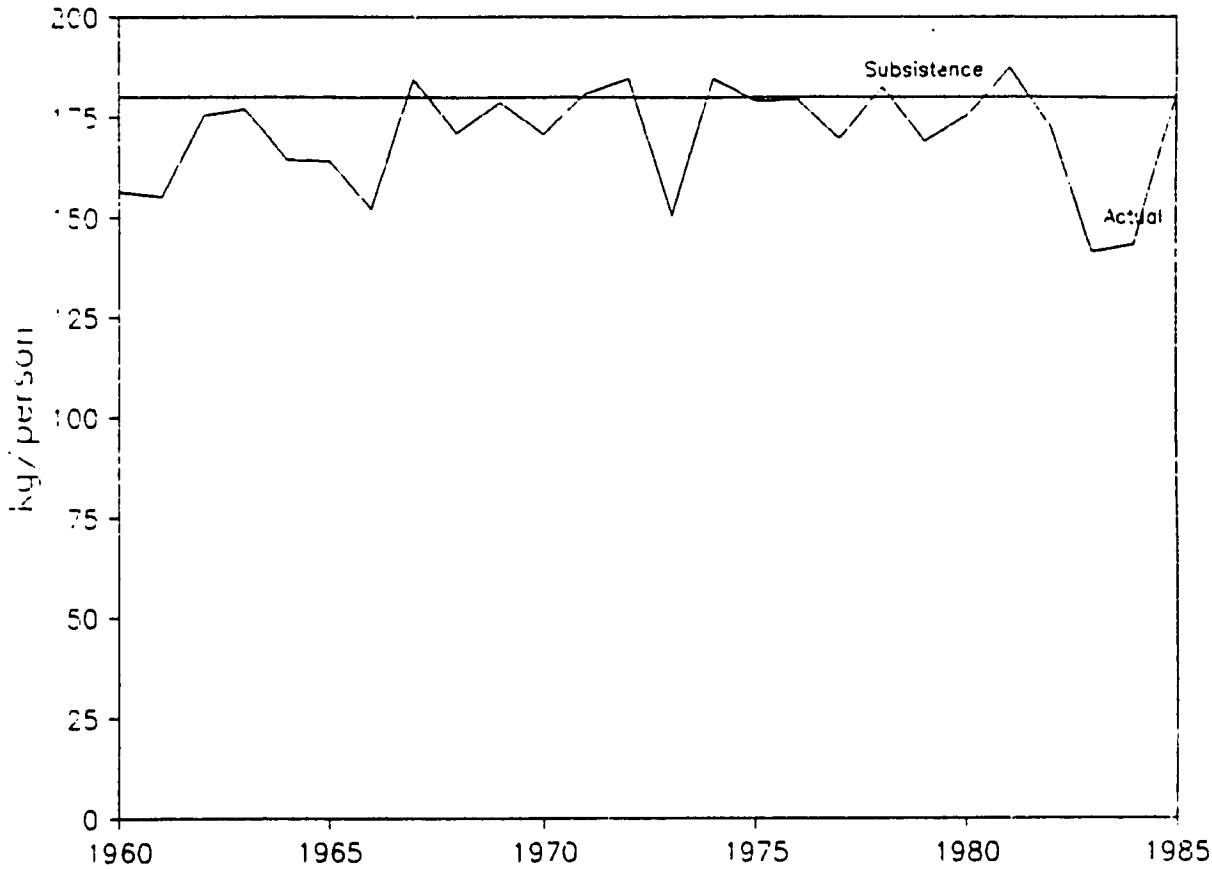
Many people raise the deep question of whether a population explosion would accompany a successful campaign to combat infant mortality--and whether it would leave developing nations worse off than with high rates of infant and child death. To be sure, Africa in particular is experiencing unsupportable population growth. The growth of human numbers in Africa has wiped out or diminished gains in per capita food availability on that continent. (See Figure 4.) Desertification and famine both contribute to and result from such imbalances.[22] Extrapolating current African trends in population and food, according to the United Nations Food and Agriculture Organization, yields "a doomsday scenario."[23]

But UNICEF, among others, has discovered that sharp reductions in child deaths lead to reductions in population growth.[24] Indeed, many techniques for reducing infant mortality--birth spacing, breast feeding, and female literacy--lead directly to reduced birth rates. Nevertheless, demographic pressures and resource realities mean that too little time exists for most developing nations to allow health improvements alone to halt population growth. Indeed, the latter may be so burdensome that it will undercut the former. Family planning programs are necessary complements to primary health care innovations.

IV. Development for Conservation

A vision of development must be matched with a theory of how to set world society on a course of energy, forest, and land conservation. Conservation

FIGURE 4: Grain Production per Capita in Africa, 1960–85



SOURCE: Worldwatch, with USDA data

ultimately requires setting limits on certain activities. For example, ozone-depleting chlorofluorocarbons may have to be banned. Fossil energy use, which drives global climate change, may have to be limited--somehow. Forest cutting, which destroys land fertility and may alter local and even global climate and may have to be restricted. Development policy can itself be fashioned to push back these limits by making resource use more efficient. Combining donor assistance--funds for energy efficiencyinvestments, technical help with reforestation, child survival efforts--with economic reform for efficiency in developing nations could critically reduce the energy, forest, and land resources needed to improve standards of living.

Development for conservation will require three elements: 1) strengthening economic signals about the value of resources; 2) protecting and renewing renewable resources; and 3) reducing environmental sources of disease, including childhood and tropical diseases. The first element suggests that pricing natural resources to reflect both their replacement costs and their environmental impacts is essential. The second suggests conservation criteria must set limits on consumption that do not exceed sustainable yields or destroy the natural resource base of the global economy. The third element suggests that basic human needs underlie the drive for development, and that satifying health and family planning needs is a prerequisite to sustainable development. These elements call for new directions in development policy in the energy, agricultural, and health sectors of developing economies.

IV.a. Efficient Energy Use

Energy use--because it produces carbon dioxide and other greenhouse gases--represents the most important climate concern. Non-fossil energy sources do not at present offer cost-effective alternatives, but detailed studies show that the world has barely cut into the potential for cost-effective energy conservation. By slowly adopting existing measures--technology for 50 mpg cars, continuous casting for energy-efficient steel-making, high-efficiency industrial motors--the world could cut the energy intensity of the global economy in half over the next 35 years. Slow energy growth would permit a shift of energy use per capita from the developed to the developing world without sacrificing living standards or development potential. Indeed, progress in development may be impossible otherwise.

The global conservation potential can be illustrated in energy portraits of a small number of nations. Some 15 countries, containing about 65 percent of the world's population, are responsible for about 80 percent of all fossil and electric energy use. Among these are developing countries such as Brazil, China, and India--nations that have a legitimate claim to a larger share of energy resources. On the other hand, developing country economies do rank among the world's least efficient in terms of energy used per unit of economic output. China, for example, uses twice as much energy per unit of economic output as the United States, and four times that of Japan or Western Europe. Still, an effort in the United States to raise automobile fuel economy to 40 miles per gallon would

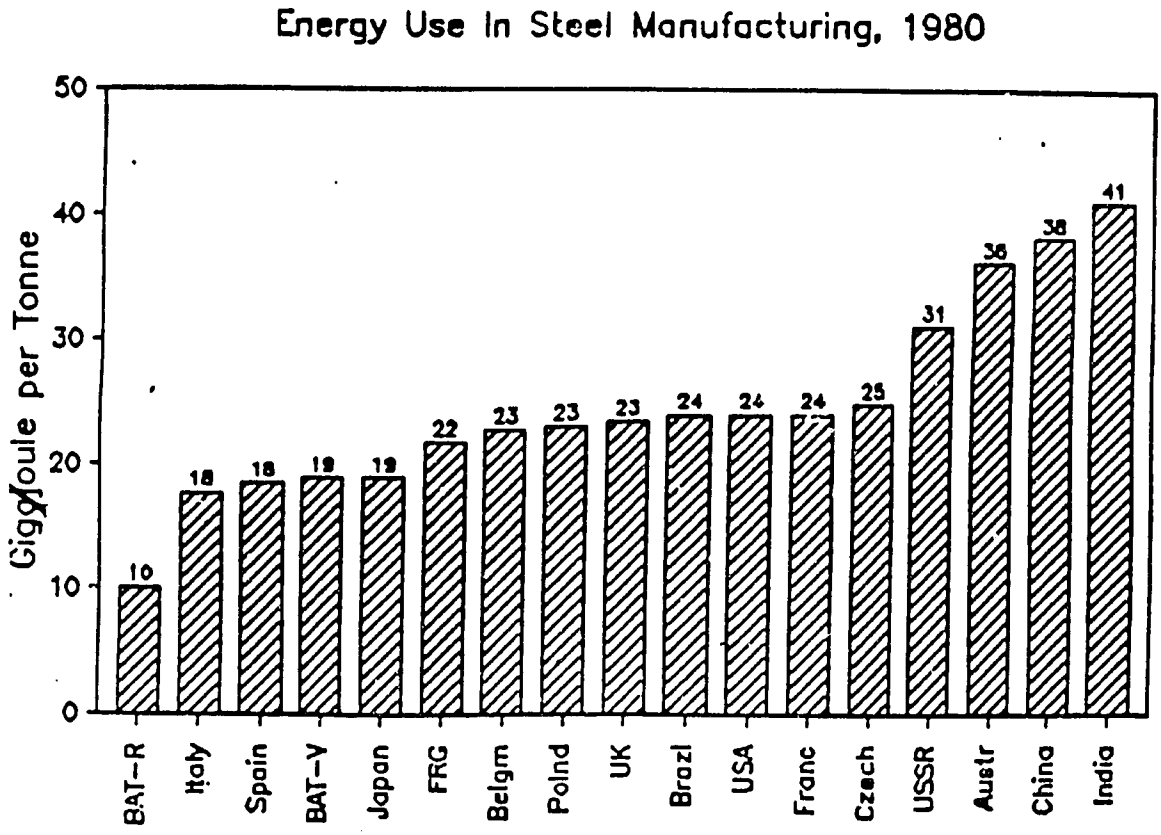
save as much energy as Brazil now consumes. So would a commitment in the Soviet Union to produce steel as efficiently as the Japanese.[25]

Industry accounts for two-thirds of Third World commercial energy consumption. Steel manufacturing alone absorbs about 6 percent of total world commercial energy use. Yet, steel manufacturing is grossly inefficient in several of the world's major producing nations. No steel making nations are less efficient than India and China, with the Soviet Union following closely in inefficiency. (See Figure 5.) These nations plan major increases in steel making.

Steel making can be made more energy-efficient both by improving existing facilities and by switching to better furnaces. An assessment of investments available to the U.S. steel industry suggests the lucrative potential of conservation the world over. Upgrading conventional furnaces yields high average rates of return: 25 percent per year for continuous casting, 31 percent for waste-heat recovery, and 43 percent for more efficient electric motors. Switching to the electric arc "recycling" furnace can yield a 57 percent rate of return. In one study of U.S. industry, physicist Marc Ross of the University of Michigan estimated that investments such as these could cut the energy required per ton of steel by a third by the year 2000.[26]

China and India also still rely heavily on the open hearth furnace and take little advantage of heat recovery opportunities. Developing countries overall could save at least 10 percent of the energy they use in existing steel facilities by spending only $2-4 billion on conservation retrofits, according to a World

Figure 5


Energy Use In Steel Manufacturing, 1980
Gigajoule per Tonne
50
40
30
20
10
0
10
18
18
19
19
22
23
23
23
24
24
24
25
31
36
38
41
BAT-R
Italy
Spain
BAT-V
Japan
FRG
Belgm
Poland
UK
Brazl
USA
Franc
Czech
USSR
Austr
China
India

Bank study. This investment would pay for itself in energy savings in just one year.[27]

Chemical processing is the world's fastest-growing industry. Typical energy efficiency investments by the chemicals industry in electric pumps, heat recovery devices, and cogeneration offer rates of return of 43, 15, and 18 percent per year, respectively.[28]

Electric industrial motors consume a remarkable 40 percent of all electricity used in Brazil. One expert suggests that by investing in more efficient motors and motor speed controls, Brazil could avoid building 10,000 megawatts of power plants by the year 2000, over 17 percent of projected new demand for generating capacity in that country. That heavily-indebted nation could thus avoid the need to borrow some $20-30 billion.[29]

The key question is how to change energy-wasting behavior to energy-conserving behavior. Energy price increases have stimulated more conservation than any other factor--witness the doubling of energy efficiency improvement rates following the two petroleum price hikes of the seventies. The United States now uses about 30 percent less energy per dollar of GNP produced than it would have if policies had not changed. Energy price increases probably caused two thirds of this conservation response, with the remaining third due to a variety of government measures such as automobile fuel economy standards.[30]

Much of the world's commercial energy use occurs in countries lacking realistic pricing mechanisms. Without decentralization--a move away from central

planning and toward enterprise autonomy and competition--and economic reform, sustainable development will remain elusive. But markets alone will not solve the climate-energy problem. There remain the problems of market failure and the fact that market-induced rates of energy efficiency probably will not be sufficient to avoid climate change.[31] Regulatory policies can provide a minimum level of efficiency where markets fail or do not exist. Obvious targets for minimum performance standards are automobiles, furnaces, water heaters, air conditioners, and heat pumps. This approach will not work well for industry, however, because industry uses thousands of processes and scores of "appliances."

The world faces two sharply contrasting visions of its energy future. One, based on past trends, indicates that global energy demand will more than double by the year 2025. The other, based on an understanding of energy economics and engineering, shows how demand could be held to a much smaller increase, stretching nonrenewable energy supplies and facilitating the use of renewable resources. Both visions have claim to validity. The one that comes to pass will depend on conscious development choices.

IV.b. Efficient Agriculture

Agricultural production can critically affect the consumption and disruption of resources--such as water, forests, and air. Soil erosion and deforestation can result from low agricultural productivity if new, marginal lands are pressed into production to make up for lost potential. Such expansions contribute to desertification. Efficiency is consequently an essential ingredient of agricultural

sustainability. Unfortunately, many developing nations still lag dramatically in land productivity. (See Table 5.)

Post-Mao China provides a rare and vast laboratory for testing the economic and environmental benefits of decentralization in agriculture. The shift to market incentives in China boosted grain output by a third between 1978 and 1985, and provided marked improvements in per capita food availability. Significantly, this growth was achieved along with a 4 percent reduction in cultivated area, as highly erosive land was taken out of production, and a decline in water and pesticide use. The increases in output and efficiency translated into higher rural income, which have grown as much since 1978 as in the previous 30 years.[32]

In the West, resource efficiency is undermined by heavy farm production subsidies, including trade barriers and direct budgetary expenditures. Misallocation of resources in this way undermines economic sustainablity. When the efficiency of resource use declines, real costs go up. Governments often compound the problem by protecting consumers from rising food prices with further subsidies, which can drive budgets into deficit and economies into decline. When supports exceed world market levels, they interfere with trade, stimulate environmentally disruptive overproduction, and waste money. These distortions have political motivations that may well be worthy. But they are environmentally and economically unsustainable, and they undermine leadership in development reform.

Table 5: Productivity in Grain Production, Selected Countries, 1984

Country	Labor Productivity (Tonnes/worker)	Land Productivity (Tonnes/hectare)
United States	160.3	4.4
United Kingdom	57.3	6.6
France	34.2	6.0
Hungary	23.6	5.4
Soviet Union	8.5	1.4
Yugoslavia	5.2	4.2
Mexico	2.6	2.6
Japan	2.1	4.1
Philippines	1.1	1.4
Egypt	4.0	4.0
China	1.1	3.3
India	1.3	1.3

SOURCE: U.S. Department of Agriculture, Economic Research Service data printouts.

IV.c. Healthy Populations

Experience in China and Sri Lanka indicates that infant mortality can be reduced to industrial country levels despite very low per capita income levels. These nations have provided clean water supplies, promoted sanitation, and made available low-cost primary health care. More importantly, they have made a commitment to female literacy, which in general is the most important factor in child survival.[33]

Achieving the goal of reduced infant mortality will not suffice without complementary development and population planning programs.[34] Family planning must be provided in parallel with primary health care if either is to succeed. Fortunately, experience suggests this may be possible. In Jamkhed, India, the practice of family planning increased from 10 percent of families in the community to 50 percent when a primary health care clinic was installed. In Miraj, India, a similar project raised family planning participation from one-third to nine-tenths of the families. Moreover, as demonstrated in China, Sri Lanka, Korea, Costa Rica, and Singapore, reduced infant mortality reduces the incentive to give birth to more children than a couple really wants--for fear they will not survive.[35]

The United States, which has seen an explosion of development in the biotechnical sciences, may uniquely offer the potential to control debilitating tropical diseases. Vaccines for malaria, schistosomiasis, and leishmaniasis, for example, would be of inestimable value for the developing world.

Although a vaccine for malaria may be available within a decade, most trends in commercial biotechnology suggest that vaccines for tropical diseases will be slow in coming. Producing new drugs is an expensive and risky business venture. Developing and testing a new vaccine for market can take over 7 years and cost more than $70 million. Commercial firms are naturally more likely to sponsor research for drugs with lucrative markets. Thus, the diseases of affluence take precedence over the diseases of poverty. Publicly-sponsored scientific research could take up this worthy effort in the absence of commercial development. But U.S. scientific and development agencies have not come close to exploiting the potential bio-science offers for improving the human condition in the Third World.[36]

V. Conclusion

The prospect of global environmental change raises development assistance and development reform to a new level of urgency. Unguided development carries the potential to catastrophically alter the earth's climate by producing greenhouse gases from energy use and deforestation. Inefficiency and population growth fundamentally drive these problems. But development assistance, by providing the capital, skills, and conditions necessary for efficient resource use, could push back the constraints that limit improvements in the human condition. This means that the old character of the conflict between environment and development has changed forever. No longer is the claim valid that "developing countries cannot afford environmental protection." Moreover,

the United States, like all nations, now has an environmental stake in the development policies of all other nations. The implication is that the United States will have to revise its approach to development assistance. That is, it will be forced to consider environmental impacts in its selection of projects, and reconsider its priorities and shift funds into efforts to make development "sustainable." These efforts must include assistance in structural reforms designed to reduce simultaneously economic and resource waste.

Markets alone cannot accomplish all that is needed, but to a large degree they offer a self-administering check on resource waste: the resource user pays for inefficiency. Government control of the production and prices of resource-intensive goods and services has led to excessive consumption and unnecessary environmental degradation.[37] Market failure and over-exploitation have also degraded the global environment. Governments must set boundaries on non-sustainable rates of consumption.

In summary, six priorities arise. First, energy efficiency can be improved worldwide, and a rate of 2 percent per year is possible. Second, infant mortality can be cut to Chinese levels thoughout the developing world. Third, population growth rates can be dramatically reduced by coupling family planning services with primary health care. Fourth, small-scale agriculture, the primary economic activity of the developing world, can be significantly improved with decentralized incentives and financing. Fifth, deforestation can be halted and fuelwood needs satisfied. And sixth, nations can cooperate to begin controlling industrial emissions of CFCs, methane, and other specific threats to global climate.

Each of these goals is possible--each is urgently needed. Some require U.S. funds, some its technical expertise and scientific resources. But the policies requiring adjustments of resource use most importantly require U.S. leadership, for American inefficiency, waste, and pollution will undercut efforts to eliminate them elsewhere in the world.

Notes

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Carbon dioxide's greenhouse effect is simple. Carbon dioxide is a strong absorber of electromagnetic energy in the band of 13-18 microns. As a result, radiance from the earth's surface at a temperature above about 220 degrees Kelvin is blocked, and the heat retained.

A great uncertainty for the carbon dioxide greenhouse effect is the linkage of climatically important mechanisms with the oceans. Only about half the emitted carbon has remained in the atmosphere. The oceans remove carbon dioxide from the atmosphere, store heat, transport heat, interact with ice, and provide a source of water vapor. They also contain an enormous sink for carbon dioxide in the form of clathrates, which if heated could release prodigious quantities of carbon.

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