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ABSTRACT

This paper discusses six steps which must be taken on a global level to put society on a sustainable path. Of the various steps none is more important than bringing population growth to a halt. The official United Nations medium-level population projects, used by planners throughout the world, show world population reaching some 10.5 billion before eventually stabilizing a century or more from now. It is recommended that the world population be stabilized at the six billion level by the year 2000. The second step to a sustainable society is protecting the croplands that are the main source of food worldwide. An understanding that soil loss eventually means less and costlier food is needed if a national soil conservation ethic is to be adopted. The third step is reforesting the earth. The World Bank now supports community-based forestry projects along with the commercial timber ventures it has traditionally backed. The fourth step is to repair, reuse, or recycle goods. The fifth and sixth keys to the evolution of a sustainable society is the conservation of energy and the development of renewable energy. (RM)

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Six Steps to a Sustainable Society

Lester R. Brown
Pamela Shaw

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The world of the early eighties is beset by economic stresses on every front. Double-digit inflation has become chronic in many countries, while double-digit unemployment threatens even the advanced industrial societies in North America and Western Europe. Global economic growth has slowed to a snail's pace. The World Bank has reported a sustained decline in per capita income over the past decade for some 15 of its member countries.¹

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Regardless of the level of development or the type of government, policymakers everywhere are having difficulty formulating economic programs that work. The reason is not a precipitous fall in the quality of the economists who sit at the elbows of national political leaders, but rather the changing circumstances in which economic policy is formulated. At the heart of this shift is the changing relationship between ourselves, now numbering 4.4 billion, and the environmental systems and resources that support us.

It is increasingly clear that the world is on the edge of an environmental crisis that is undermining the global economy. The basic biological systems—forests, grasslands, fisheries, and croplands—that supply our food and many of the raw materials for industry are deteriorating in much of the world. The cheap oil and its synthetic derivatives that obscured the early deterioration of these environmental support systems are gone forever. Against this backdrop, failure to recognize and respect the carrying capacity of these systems is leading to economic stresses that may become unmanageable.

The gradual pace and sometimes invisible nature of environmental deterioration often masks the extent of the problem. Yet soil erosion is draining the land of its productivity and contributing to ever-growing food deficits in scores of countries. Deforestation is reducing firewood and lumber supplies and driving the cost of cooking fuel upward in Third World villages and the cost of housing upward everywhere. Overfishing and overgrazing have become commonplace,

This paper distills the principal policy recommendations from *Building a Sustainable Society* by Lester R. Brown (W W Norton, October 1981)

6 contributing in recent years to a steady decline in per capita supplies of seafood and beef worldwide. This shrinkage of the economy's environmental resource base aggravates inflation, increases unemployment, and eventually reduces living standards.

Environmental crises are not new. Archaeological sites on every continent are littered with the remains of civilizations that were unable to cope with the forces of environmental degradation. The difference today is the rate and scale pressures that once accumulated over centuries, or even millennia, are now compressed into decades. If we do not act quickly to protect and sustain the economy's environmental support systems, we will not be able to sustain the economic system itself.

Clearly, traditional economic approaches are sorely inadequate when it comes to the challenge of securing the global resource base. The new sources of economic stress require public policy initiatives that go far beyond mere adjustments in fiscal and monetary policy. Our prospects hinge ultimately not on our ability to fine tune economic policies, but on our success in stabilizing our numbers and protecting our environment.

Deterioration of the Resource Base

During the growth-dominated postwar decades, the world became accustomed to focusing on short-term rates of growth, neglecting the longer term effects. Few stopped to calculate, for example, that a 3 percent annual rate of population growth leads to a 19-fold increase in a century, or that a continuation of the 4 percent annual rate of world economic growth that prevailed from 1950 to 1973 would lead to a 50-fold expansion of the global economy within a century—and to an associated increase in demand for resources. With the benefit of hindsight, it is now obvious that between 1960 and 1976—as world population went from three billion to four billion—human demands began to outstrip the sustainable yield of the basic biological systems that support the global economy.

"Traditional economic approaches are sorely inadequate when it comes to the challenge of securing the global resource base."

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Throughout most of the third quarter of this century, the per capita production of most of the basic commodities on which economic activity depends, such as lumber, seafood, beef, grain, and oil, increased. But as world population approached the four billion level, this began to change. The amount of wood harvested per person worldwide peaked in 1964, for example. Since then it has fallen some 11 percent.² (See Table 1.) The principal reason for the fall is not lagging demand but an excessive pressure on forests that has led to deforestation and a shrinkage of the resource base in many areas. During the late twentieth century the pressure on the more accessible forests has mounted steadily. In some parts of the Third World, often where population policies are non-existent or unrelated to the carrying capacity of local biological systems, forests have largely disappeared.

When the readily available supply of wood has dropped, lumber prices have often led the overall rise in inflation, as in the United States since 1967. In some Third World countries the cost of firewood climbed almost as fast as the price of kerosene over the past decade. This often translated into a decline in the standard of living for both urban and rural dwellers, many of whom must trade off the cost of the food they eat against the cost of the fuel to cook it.

With the world fish catch, the decades immediately following World War II brought an enormous growth in production. Advancing technology and cheap oil permitted the development of distant-water fishing fleets by Japan, the Soviet Union, and other countries. The result was an increase in the world fish catch from some 22 million tons in 1950 to nearly 70 million tons in 1970.³ This tripling in the fish catch over two decades more than doubled the amount of fish available per capita, from 8 to over 18 kilograms.

But by 1970 few unexploited oceanic fishing areas remained, and many freshwater fisheries had become so polluted that governments were declaring the fish caught there unsafe for human consumption. By the late sixties and early seventies, overfishing was contributing to the collapse of some of the world's most important fishing sites, ranging from the haddock fishery in the North Atlantic to the primary anchovy area off the western coast of Latin America.⁴ Since

Table 1: World Per Capita Production of Basic Commodities, 1950-1981, With Peak Year Underlined

Year	Wood (cubic meters)	Fish (kilograms)	Beef (kilograms)	Grain (kilograms)	Oil (barrels)
1950	—	8.4	—	251	1.5
1955	—	10.5	—	264	2.0
1960	—	13.2	9.3	285	2.5
1961	.66	14.0	9.6	273	2.7
1962	.65	14.9	9.8	288	2.8
1963	.66	14.7	10.7	282	3.0
1964	<u>.67</u>	16.1	10.1	292	3.1
1965	.66	16.0	9.9	284	3.3
1966	.66	16.8	10.2	304	3.5
1967	.64	17.4	10.4	303	3.7
1968	.64	18.0	10.7	313	4.0
1969	.64	17.4	10.7	311	4.2
1970	.64	<u>18.5</u>	10.6	309	4.5
1971	.64	<u>18.3</u>	10.4	330	4.7
1972	.63	16.8	10.6	314	4.9
1973	.64	16.8	10.5	332	<u>5.3</u>
1974	.63	17.7	11.0	317	<u>5.2</u>
1975	.61	17.2	11.3	316	4.8
1976	.62	17.7	<u>11.6</u>	337	5.1
1977	.61	17.3	11.5	330	5.2
1978	.61	17.3	11.4	<u>351</u>	5.2
1979	.60	16.9	10.9	<u>331</u>	5.3
1980	.60	16.1	10.5	324	4.9
1981 (prel.)	—	—	10.4	331	4.5

Source: Food and Agriculture Organization, U.S. Departments of Agriculture and Energy, and U.N. Demographic Division

1970 the fish catch per capita for the world as a whole has declined some 13 percent, the result is growing competition for available seafood resources and rising seafood prices. 9

The growth in world beef production during the third quarter of this century was more gradual and somewhat less dramatic than that of fish, but the cessation in growth was no less abrupt. By 1976 constraints on grazing capacity meant many of the world's ranchers and herders could no longer readily expand their herds in response to the continuing growth in demand. The alternative was to shift more and more cattle into feedlots, but rising feedgrain prices made such a step too costly. Since 1976, when world beef production per person peaked at 11.6 kilograms, the decline has been steady. In 1981 per capita beef production was some 11 percent below the peak reached in 1976.

World grain production also increased impressively during the post-war decades. Between 1950 and 1971 world grain production doubled, leading to a 30 percent increase in the amount of grain available per capita. After 1971, the growth in production lost momentum and per capita gains stagnated.⁵ Since then, there has been little progress in raising per capita output of this most basic of foodstuffs.

Only once in the last decade has per capita grain production been significantly above the 1971 level: in 1978, a year of bumper harvests worldwide. Given the falloff during the three years since, this could in fact become the historical peak that precedes a long-term gradual decline in supplies per person similar to those for seafood and beef. Africa, plagued with both widespread soil erosion and the fastest continental population growth rate on record, has already experienced such a downturn.⁶ Since 1970 its per capita grain production has fallen 13 percent, or more than 1 percent per year.

The soil erosion that has undermined agricultural production in so many of the countries that currently import food from the US and Canada now threatens productivity in the North American breadbasket itself. Recently released U.S. Department of Agriculture (USDA) data show 34 percent of the country is losing topsoil at a rate that is

reducing its inherent productivity. On 4 percent of the total, or roughly 17 million acres, the loss is so severe that the Soil Conservation Service recommends it be converted from continuous cropping to grassland, woodland, or long-term rotations, lest it lose its productive capacity entirely.⁷

As pressures on the earth's natural biological systems and croplands multiplied during the century's third quarter, ingenious ways were found to lighten them by substituting oil in one form or another. In effect, the sixfold increase in world oil production between 1950 and 1979 served as a safety valve. Although there was relatively little new land to bring under the plow after mid-century, for example, the world's farmers could continue to expand food output by substituting oil-derived chemical fertilizers for cropland. Between 1950 and 1980 chemical fertilizer use climbed from 15 to 113 million tons. Similarly, as deforestation progressed in the Third World, villagers substituted kerosene for firewood. Plastic was substituted for paper in packaging and for wood in home furnishings. And textile manufacturers shifted from natural to synthetic fibers for over one-third of their needs.⁸

As the seventies ended, oil output turned downward as prices climbed, and the oil safety valve began to close. Per capita oil production, which had remained essentially unchanged from 1973 to 1979, fell some 15 percent between 1979 and 1981. If world population grows as projected, a continuing, though irregular, long-term decline in per capita oil production seems inevitable. Pressures on the earth's biological support systems will increase accordingly. In such a world, a reassessment of national population and economic policies is essential if the economy is to be sustained.

At some point, environmental deterioration translates into economic decline and, ultimately, social disintegration. The evidence now becoming available from various archaeological sites permits us to reconstruct some of the environmental-economic linkages. The role of deforestation, overgrazing, soil erosion, desertification, and the water-logging and salting of irrigation systems in the decline of earlier civilizations is increasingly clear. What is missing in the archaeologi-

"A recent World Bank study reports that per capita income for the low-income countries in sub-Saharan Africa declined an average of 3 percent during the seventies."

cal findings, unfortunately, are any precise clues about how economic decline translated into social disintegration. Moreover, though the historical records indicate that environmental deterioration can lead to economic decline, recent progress in improving living standards has become so nearly universal and so taken for granted that people today have little experience with such a chain of events. 11

In a growing number of countries, however, policymakers can no longer afford to dismiss the link between environmental deterioration and economic stress. A recent World Bank study reports that per capita income for the low-income, non-oil exporting countries in sub-Saharan Africa—a group of 24 countries containing 187 million people—declined an average of 3 percent during the seventies. More importantly, unless there are major domestic policy reforms and a massive infusion of external assistance, the Bank projects the decline will accelerate, falling a further 10 percent during the eighties.

Much of the decline in per capita income in sub-Saharan Africa is due to the decline in per capita food production that has plagued the continent since 1970. This in turn can be traced to a lack of trained personnel and of institutions to support agricultural modernization, as well as to agricultural mismanagement in many forms, including food price policies that do not encourage production. But the principal factor undermining the region's economy in the long run is the continuing deterioration of its agricultural resource base. Africa's population growth acts as a double-edged sword. It increases simultaneously the need for food and pressures on the agronomic base. Soil erosion, soil degradation, and desertification are proceeding at a record pace. The wholesale agronomic deterioration now under way casts a long shadow over the future of many sub-Saharan countries. Unless checked, this deterioration will eventually make gains in per capita food output impossible, even if appropriate economic priorities and agricultural policies are adopted.

Without a major commitment of outside funds, it is difficult to see how this process of deterioration can be readily reversed. Yet there are no initiatives in sight from within Africa or outside that have the potential to reverse the negative trends that have emerged. What is

happening in Africa is also beginning to occur elsewhere—in the Andean countries of Latin America, in Central America, on the Indian subcontinent, in the Middle East, and in other parts of Asia.

The last half of the twentieth century divides into two economic eras that coincide more or less with its third and fourth quarters. During most of the third quarter, as indicated above, the per capita production of the basic commodities on which the global economy depends—lumber, grain, seafood, beef, and petroleum—increased. During the final quarter the per capita production of each may be declining. Thus the economic policies that worked so well during most of the third quarter of the century may not work well at all in the far different environmental circumstances of the final quarter. If governments continue to pursue inappropriate economic and demographic policies, they may be rewarded with a falling standard of living for their people.

In a world where the economy's environmental support systems are deteriorating, supply-side economics—with its overriding emphasis on production and its near blind faith in market forces—will lead to serious problems. Among other things, such a policy will drive the world up steeply rising, inflationary cost curves in both the energy and food sectors. The market has no alarm that sounds when the carrying capacity of a biological system is exceeded. Only when the system collapses and prices soar does the market "know" that anything has gone wrong. By that point, the damage has been done. In a world where population has passed the four billion mark and is now heading for five billion, the unalloyed working of market forces can destroy the very croplands, forests, grasslands, and fisheries that support the economy.

The new circumstances call for a new approach to national policy-making, one that gives environmental and population policies a far more prominent place in relation to economic policies in the more traditional sense. Halting the environmental deterioration now under way and slowing the forces that have given it such momentum will require major initiatives. Unless we can stabilize our numbers far below the 10.5 billion level currently projected, further improvements in

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living conditions will become increasingly difficult. If we cannot conserve the topsoil that is used to produce our food, civilization as we know it cannot survive. To satisfy future demands for firewood, lumber, and newsprint, a massive tree planting effort must begin now. Although initial steps to design a more energy-efficient economic system have already been taken, the potential has scarcely been tapped. Further, the systematic recycling of materials is an essential component of a sustainable society. And finally, instead of continuing the rapid depletion of nonrenewable fossil fuels, we should give top priority to tapping renewable energy sources.

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Stabilizing World Population

Of the various steps needed to put society on a sustainable path, none is more important than bringing population growth to a halt. Indeed, the other initiatives—such as cropland protection, reforestation, and energy conservation—have little chance of success unless we get the brakes on population growth.

The recent per capita declines in fish catch, beef production, forest products, and, in Africa, food production have not been due to a decline in overall output but to an inability to expand overall output as fast as population growth. The impact of the global economic slowdown will be greatest in those societies where population growth is most rapid. A fall in the economic growth rate to 2 percent per year does not pose any problem in West Germany or Sweden, where population growth has ceased. Incomes there would still rise by some 2 percent per year. But it could wreak havoc in Pakistan or Senegal, where population is still expanding by 3 percent or more per year.¹⁰

The official U.N. medium-level population projections, used by planners throughout the world, show world population reaching some 10.5 billion before eventually stabilizing a century or more from now. A second set of projections, made by the World Bank and published in its World Development Report for 1980, show world population growth stabilizing at a somewhat lower level of 9.8 billion. Central to both the U.N. and World Bank figures is the assumption that in

countries where fertility is high, it will decline as economic and social development occurs.¹¹

Even under the Bank's projections, which take into account recently reported fertility declines in developing countries, the growth in store for some countries can only be described as phenomenal. Nigeria's population of 85 million today is projected to reach 425 million before leveling off, almost as many people as now inhabit all of Africa. India is projected to add nearly another billion people to its 1980 population before stabilizing at 1.64 billion, while neighboring Bangladesh is expected to increase from 89 million to 314 million and Pakistan from 82 million to 332 million. If all these projections hold true, the Indian subcontinent would be home to 2.3 billion people—more than the entire world population of 1940.

These population projections reflect two sets of assumptions—one explicit and one implicit. Among the explicit are the country-by-country assumptions about future fertility levels, sex ratios, life expectancies, and numerous other demographic variables. If these assumptions are correct, then world population would indeed reach the levels projected by the U.N. and the World Bank. But population growth does not occur in a vacuum. Current projections of world population are based on the implicit assumption that the supplies of energy, food, and the other natural resources needed to support human life will continue to be available.

Yet the pressures of population growth and rising affluence are affecting the availability of those resources, and, thus, future population trends. To be realistic, demographic models need to incorporate feedback mechanisms that reflect the changes in attitudes toward population size as the various ecological and economic stresses associated with continued population growth materialize. This, in turn, calls for improved analyses and understanding of the relationship between population growth and the earth's basic life-support systems, including energy supplies.

Several countries have begun to consider the connections between their resources and their population growth. In Egypt, the leadership

was jolted into action by the calculation that the population increase in the Nile River Valley during the time the Aswan High Dam was under construction would totally absorb the additional food production the irrigation project would make possible.¹²

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In China, as part of the broad policy reassessment since Mao's death, the new leaders have taken a second look at the population/resource balance and the prospects for the end of the century. The handwriting on the wall appears distinctly Malthusian. As the dimensions of the population threat have become clear, the Chinese leadership has initiated public discussion and distributed background information on the population/resource relationship. Now people understand both how their national population/resource base compares with other countries and what changes are in store within China if population continues to increase. In particular, the literature points out that each Chinese currently subsists on scarcely one-quarter of an acre of cropland, one of the smallest per capita allotments in the world, and that future generations will have even less if population growth continues.¹³

Perhaps the most surprising development in population policy has taken place in Canada; where future resource supplies have become a matter of public discussion. Many Canadians are disturbed by the recent loss of an exportable energy surplus, a loss that occurred as domestic needs soared. At the same time, agricultural planners alarmed by the sacrifice of the most fertile cropland to urban sprawl fear Canada's exportable food surplus may also begin to decline. A recent study by the Science Council of Canada suggests aiming for an end-of-century population of 29 million, an inarguably modest increase over the current 22 million. If such a study leads to concern in this resource-rich country, what would similar analyses prompt other, less well endowed countries to think and, more to the point, do?¹⁴

Getting the brakes on population growth quickly will severely strain social and political systems, but continuing on the current demographic trajectory toward a world of more than ten billion people will entail ruinous environmental stresses. Bringing population growth to a halt requires a goal that balances these two sets of stresses. Such

equilibrium might be achieved by trying to stop population growth at the six billion level by the year 2020. That will be extraordinarily difficult, but not impossible. To meet this goal, no developing country would have to do anything that at least a few countries have not already done. No country would have to reduce its birth rate any more rapidly than Barbados, China, Costa Rica, and Indonesia did over the last decade or so.¹⁵

Stabilizing world population at six billion will have to occur in stages, with developing countries following a slower timetable than the industrial nations. For their part, the industrial countries as a group would have to achieve a stationary population by the year 2000. In fact, several industrial countries have already reached this goal. Austria, Belgium, East Germany, Luxembourg, Sweden, the United Kingdom, and West Germany had essentially stationary populations in 1980. The population of West Germany, which stopped growing in 1972, is now actually declining by 80,000 per year. Most of the remaining industrial countries that have relatively slow-growing populations are likely to halt growth well before the end of the century.

Interestingly, in the seven countries where population size is now stationary, stabilizing the number of people in the society was not a national goal. Rather, the decline in fertility flowed from social improvements. As levels of education and literacy rose, as employment opportunities for women expanded, as access to family planning services improved, and as abortion laws were liberalized, people chose to have fewer children.

The developing world will need more time to rein in population growth. The first step would be to reduce the average annual birth rate from its 1980 level of 32 per thousand to 26 by 1990. Thereafter the rate could drop steadily until it reached 11 in 2020, roughly the same as in Austria, Sweden, or West Germany today. The crude death rate, rather than continuing the postwar decline, may well remain for a decade at the level it reached in 1980, largely as a result of higher food prices and the severe nutritional stresses now developing in such areas as sub-Saharan Africa. As population growth slowed by the year 2000, however, the enhanced potential for improving nutrition

would permit the death rate to drop again. Although additional improvements in living conditions would tend to lower the death rate even further, this would be offset by the aging of the population that follows a sustained decline in fertility.

Lowering the average birth rate in the developing countries to 26 by 1990 will require a Herculean effort, one that many observers consider impossible. Although not all countries will reach this target, some are far ahead of schedule. Birth rates in Taiwan and South Korea are now 25 or below, while those in Barbados, China, Cuba, Hong Kong, and Singapore are below 20. The keys to meeting the timetable are China and India. China, whose population accounts for one-third of the developing world, already has a birth rate of 18; India's 1980 birth rate was estimated to be 34 per thousand. Combined, then, India and China have a 1980 birth rate of 24, already well below the target for 1990.

Under this timetable, the substantial declines in birth rates between now and 1990 in both the industrial and the developing countries would yield a world population growth rate of 1.1 percent in that year. (See Table 2.) The timetable is admittedly ambitious, but attitudes toward family size are changing and birth rates are stationary or falling almost everywhere. With effective national leadership, this goal is clearly attainable.

Table 2: A Proposed Population Stabilization Timetable

Year	World Population (billions)	Annual Growth Rate (percent)	Annual Increase (millions)
1970	3.6	1.9	69
1980	4.4	1.7	75
1990	5.0	1.1	55
2000	5.5	0.8	44
2010	5.8	0.4	23
2020	6.0	0	0

Source: Worldwatch Institute

Thus far, much of the global slowdown in population growth is concentrated in a few of the world's most populous countries. The decline in China's birth rate between 1970 and 1980, among the most rapid of any country on record, may be family planning's greatest success story. This achievement in a country where more than one-fifth of humanity resides shows what a government committed to reducing fertility can do when it attacks the population problem on several fronts simultaneously.

Providing family planning services to all who want them is one of the most obvious ways governments can help slow population growth. Despite steady progress over the last decade in expanding the availability of contraceptive services, much remains to be done. By even the most conservative estimates, vast numbers are not yet served by family planning services. According to one study based on data gathered during the mid-seventies, close to half the world's couples have no protection from unplanned pregnancies.¹⁶

Data becoming available from the World Fertility Survey—a project in which some 350,000 women from 19 developed and 41 developing countries are being asked about their childbearing practices, beliefs, and desires—sketch out the dimensions of the family planning gap. In a detailed analysis of Colombia, Panama, Peru, Indonesia, South Korea, and Sri Lanka, demographer Charles Westoff concludes that “the prevention of unwanted births . . . would reduce fertility by one-quarter to one-third in five of the six countries.”¹⁷

To be widely used, family planning services need to be readily accessible, preferably within 30 minutes travel time from the residence of the potential user. In addition, the services and contraceptive materials themselves must be either free or cheap. In explaining China's highly successful program to an American delegation, Chinese official Liu Ching-Shen said “we practice the principle that anyone who wants birth planning can get it, and the government should pay for it.” Experience also indicates that the more successful family planning programs offer both males and females a wide range of family planning services and that clinic-based contraceptive services are usually less effective than community-based efforts that involve local

"The decline in China's birth rate between 1970 and 1980 may be family planning's greatest success story."

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people in setting goals for the birth rate, designing the program, and delivering the services. Indonesia's family planning program, which blends government initiative with local custom, has led to an impressive drop in fertility levels. On the island of Java alone 27,000 village pill and condom depots, many of them in private homes, provide ready access to contraceptive supplies.¹⁸

Regardless of the efforts made to meet these criteria for success, achieving a stationary population will be painfully difficult if contraceptive services are not backed by legal abortion. With the legalization of abortion in Italy in 1978, the share of world population living in societies where abortion is readily available reached two-thirds, up from one-third a decade ago. Yet this means one-third of the world's women are still denied this basic public health service except on illicit terms.¹⁹

Of all social indicators, the one that seems to correlate most closely with fertility decline is a rising level of education. Survey data from 27 studies in the Third World show that women and men who have a primary education have fewer children than those who do not. Fertility also declines when nations urbanize and when more women work outside the home. At the lower end of the social spectrum, among farmers and couples in rural areas, when both the husband and wife have less than a primary education and when the woman does not work the average number of children is 6.9. At the other end of the spectrum, when both have at least a primary-level education or live in a city and when the woman works, the average is 4.2 children.²⁰

Expanding employment opportunities for women can also help curb birth rates. In nearly all the advanced industrial countries, the rising employment of women is combining with other social and economic trends to reduce fertility. In the United States, the share of women in the prime childbearing years who are working has climbed from two-fifths in 1960 to two-thirds in 1980. Similar trends are unfolding in Europe. In the Soviet Union, 93 percent of women aged 16 to 55 are either employed or in school. Soviet demographer Galina Kiseleva writes that this great increase in female employment has brought

about a transformation of a whole range of women's needs, including that for children.²¹

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Besides ensuring ready access to family planning services and improving social conditions, governments can also use public policy to encourage smaller families. In societies where women are widely employed outside the home, maternity-leave policies can directly influence childbearing decisions. In Singapore, women in civil service or unionized jobs get two months of paid maternity leave for the first two children only. Tax policies that limit the number of "tax deductible" children can also discourage couples from having large families. As of 1973, Filipino law limits to four the number of children for whom tax deductions can be claimed. More recently, Nepal has eliminated tax deductions for children altogether.²²

In industrial countries, the fact that people are waiting until they are older to get married is keeping birth rates down; in developing countries, raising the legal age of marriage can officially encourage a drop in the birth rate. In China, the officially recommended minimum age of marriage is now 28 for men and 25 for women in the cities, and 25 for men and 23 for women in the countryside. Other techniques used by countries to encourage small families include such incentives as preferred access to housing. Singapore, for example, gives priority access to public housing to families with no more than two children.²³

Although social improvements will undoubtedly continue to help reduce family size, fertility is now falling in some communities and countries where living conditions are actually deteriorating. In such places, the keys appear to be the active local participation of people in the design and implementation of their family planning program, a broad understanding of the social need to limit population size, and the widespread realization that reducing family size may be the only way out of the poverty trap.

Save for China and a handful of other pathfinders, few countries have fully accepted the challenge of inculcating the public with an understanding of the need to restrict future population growth. Yet knowledge of the relationship between population size and the carry-

ing capacity of natural systems, particularly at the national and community levels, clearly influences people's childbearing decisions. The challenge now is to bind the family's fate to the nation's—a challenge first for governments and educators, then for individual men and women.

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For many individuals, the link between population growth and available resources has already been forged by economic stress. In a visit to southern Senegal, Swiss demographer Pierre Pradervand found that villagers there wanted to know where they could get contraceptives, how much they cost, and how well the various devices worked. Pradervand was surprised because when he visited the same village a few years earlier people had expressed little interest in family planning. Apparently, inflation had made the difference. The prices of many of the basic goods the villagers need—kerosene, clothing, grain—had doubled within three years. Although the inflationary forces that are eroding their living standards are beyond their control, the Senegalese villagers nonetheless realize that they can offset the impact of inflation by reducing the size of their families. For them, inflation has become a contraceptive force.²⁴

For many reasons, the importance of stabilizing the number of people in both families and countries has become increasingly clear to individual couples and national leaders in more and more countries. There is still a long way to go, but birth rates are now declining in many areas. By this indicator at least, moving slowly and in response to enormous pressures, the transition to a sustainable society has begun.

Protecting Cropland

Protecting the croplands that are the main source of food worldwide becomes ever more imperative as population continues to grow, given the double-edged effect of population growth on the cropland base. A growing population simultaneously generates demand for more cropland and increases the pressure to convert land to other uses.

Wherever growth is rapid, this double-edged effect can quickly lead societies into crises. At present, urban sprawl, village expansion, and highway construction claim several million acres of the world's prime cropland each year, while farmers try to wring more out of their land and to push cultivation onto ever more fragile soils.

World food output has more than doubled since 1950, yet that impressive increase has entailed land abuse so severe that fully one-fifth and perhaps as much as one-third of the world's cropland is losing topsoil at a rate that is undermining its long-term productivity. The data released by USDA in early 1981, showing that the inherent productivity of 34 percent of U.S. cropland is now falling because of an excessive loss of topsoil, underlines the gravity of the problem.²⁵

With the aid of modern farming technology—large equipment and center-pivot irrigation systems, for example—farmers in the industrial world have boosted production dramatically. In the process, however, they have often had to sacrifice windbreaks, terraces, and other soil-conserving practices such as contour farming. Bigger harvests have enabled the United States to export more and more grain, offsetting the bills for imported oil—but at the loss of millions of tons of soil each year.²⁶

In the Third World, population growth, deforestation, and inequitable land distribution all take their toll on precious topsoils. In some places, farmers without access to adequate farmland move up hill-sides, chopping trees and planting crops; without terraces, the vulnerable soil washes down the hills with each new rain. In forested regions, where cultivators developed "slash-and-burn" agriculture—clearing fields, planting for several years, and then moving on—the lengthy fallow periods essential to restoring the fertility of fragile tropical soils have shortened as more farmers try to make do with less land.

Designing an effective program to halt soil erosion is in itself a major challenge. In the United States, the Soil Conservation Service has outlined a national plan that would bring the annual loss of topsoil down to a tolerable level. In addition to the conservation systems al-

"Detailed studies on the economics of soil conservation show that the short-term costs often exceed the short-term benefits."

ready in place, over one-third of the 413-million-acre cropland base urgently needs attention. Along with the 17 million acres that the Soil Conservation Service recommends be withdrawn from continuous cropping, 141 million acres of cropland are currently losing more than five tons of soil per acre every year. On these, some form of conservation tillage such as terracing, contour farming, strip-cropping, or minimum tillage is needed.²⁷

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As of early 1982, the program outlined by USDA soil scientists remains only a proposal, it has not yet been adopted, although there is growing public recognition of the problem. Whether this program will be formally proposed and agreed upon depends on the support of the Reagan administration and Congressional leaders. It is the type of plan that a majority of the world's countries now need if their soils are to be stabilized.

Making soil conservation economically attractive to farmers may be even more difficult than designing an effective program to halt soil erosion. Detailed studies on the economics of soil conservation show that the short-term costs often exceed the short-term benefits. A study in southern Iowa found that the immediate costs to farmers of controlling erosion would be three times as great as the benefits. Similar economic realities influence the behavior of Third World farmers, who can muster little concern about the future when their very survival is at stake.²⁸

In these circumstances, only the willingness of governments to share the costs of the needed measures—terracing, contour farming, strip-cropping, cover cropping, rotating crops, fallowing, and planting shelter belts—will induce farmers to fight soil erosion. The USDA estimates that over the next 50 years the implementation of these programs would require \$103 billion in budgetary appropriations, or roughly \$2 billion per year.²⁹

Time is also at a premium—time to lay the groundwork for such massive financial investments and time to train people to do the job. Traditional approaches to financing and training are too leisurely and will not suffice. More promising is the deployment of paraprofes-

sionals. In Third World countries, the best approach may be for village leaders who are themselves farmers to receive training in soil conservation practices during the off-season so that they can help design and administer local soil-conserving plans.

Even though soil scientists can chart a national plan of action in detail, as they have in the United States, they cannot call forth the political support needed to fund and administer such a plan, in part because adopting soil-saving measures would in many cases run counter to the short-term economic interests of farmers and consumers. The cost to farmers of adopting the needed measures will raise food production costs and prices. To the extent that severely erosion-prone land is withdrawn from crop production and converted to grass or trees, food supplies will be reduced and prices will rise in the short run. Difficult though this might be to accept, the alternative is to do nothing and face soaring food costs over the long term as soils deteriorate.

Indeed, U.S. soil scientist R. A. Brink and his colleagues, writing in *Science*, question whether in a predominantly urban society anyone can generate needed support for soil conservation until the food crisis deepens. Moreover, even with proof of the long-term benefits of conservation and national plans to preserve soils, marshaling such support will take time. As B. B. Vohra, a senior Ministry of Irrigation official in India, points out, "An informed public opinion cannot . . . be wished into existence overnight. A great deal of painstaking and patient work will have to be done to wipe out the backlog of ignorance, inertia, and complacency."³⁰

The missing ingredient in current unsuccessful responses to the growing menace of soil erosion is a political will grounded in awareness. People know that food prices are rising, but most don't know quite why. An understanding that soil loss eventually means lower productivity, which in turn means less and costlier food, is needed if a national soil conservation ethic is to be adopted. Given the necessary information, more people will understand not only the compelling environmental reasons for adopting such an ethic, but also the economic payoff in implementing a program based on it.

"An understanding that soil loss eventually means less and costlier food is needed if a national soil conservation ethic is to be adopted."

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The global cropland base is also threatened by the conversion of agricultural lands to other uses. In the midwestern United States, shopping centers stand where only a few years ago corn grew. West Germany is losing 1 percent of its agricultural land to urban encroachment every four years. In southern China, factories are being built on land that for generations yielded two rice harvests annually.²¹

Rising food prices make it clear that agricultural land can no longer be treated as an inexhaustible reservoir for industrial development, urbanization, and energy production. On the contrary, cropland must be viewed as irreplaceable—a resource that is paved over, built upon, or otherwise taken out of production only in emergencies and only after public deliberation and choice.

Historically, the marketplace has functioned as the arbiter of land use. Unfortunately, though, the market does not protect cropland from competing nonfarm interests. For that, careful land-use planning is needed at both the national and local levels. Whether in the form of legislation, government decrees, or such incentives as differential tax rates, the only defenses against the ultimately destructive opportunism of the marketplace are land-use planning and restrictions.

Until recently, most governments have stayed out of land-use planning. But many that have rationalized their neglect have overlooked the fact that both national and local governments shape land-use patterns—whether or not they view themselves as planning authorities. Within the United States, scores of national policies and over 20 federal agencies have directly or indirectly influenced land use through decisions on matters ranging from highway construction to irrigation subsidies.²²

A study by the Organisation for Economic Co-operation and Development (OECD) comparing land-use planning internationally reported that Japan is the only country with comprehensive zoning nationwide. In 1968, the entire country was divided into three land-use zones—urban, agricultural, and other. In 1974, the plan was further refined to include forests, national parks, and nature reserves.

Acutely pressed for space and land-based resources, Japan has faced the issue first, developing a model that other countries can emulate. Indeed, even though its 117 million people are crammed onto a mountainous sliver of land smaller than California, Japan manages to produce an exportable surplus of rice, the national food staple.³³

Among the Western industrial countries, France appears to have by far the most effective farmland preservation program, thanks to the work of local Sociétés d'Aménagement Foncier et d'Etablissement Rural (SAFERs). SAFERs were authorized in 1960 as nonprofit organizations and were empowered not just to buy and sell farmland, but to preempt any sale. As of 1981, SAFERs cover virtually all of France. Between 1964 and 1975 they purchased 2.1 million acres of land and sold 1.7 million acres. Although they buy only about 12 percent of the agricultural land up for sale, their influence is far greater. Even when not exercised, their right of preemption has an important effect on market behavior.³⁴

Within the United States, national land-use planning remains rather rudimentary. So far, the government has done little beyond setting aside national parks, forests, and wildlife reserves. Most zoning is local, consisting largely of restricting the use of land for commercial purposes. Although local government efforts to protect agricultural land were nil before the seventies, several states have since launched programs to preserve farmland.

One of the first steps that states customarily take to preserve farmland is to enact differential tax-assessment laws, so that no matter what alternative worth farmland might have it is assessed for its value in agricultural use. As of early 1980, laws or constitutional amendments in 46 states enabled local governments to assess taxes on such a basis. In New Jersey, passage of the Farmland Assessment Act of 1964 slowed the conversion of farmland to other uses. "If farmland in New Jersey were to be taxed at the going rate for urban and suburban residential and industrial uses," says New Jersey Secretary of Agriculture Phillip Alampi, "it would be impossible to maintain agriculture as a business in the state."³⁵

A second technique for preserving farmland—the purchase of development rights from farmers—surfaced in the early seventies to a warm reception. This approach involves getting two assessments for the value of land—its value for development, and its value for farming. The differences between the two, the “development rights” for the land, can be purchased from farmers by either state or local governments and held in perpetuity, regardless of how many times the property changes hands. Once such development rights have been purchased, land can be used only for farming. The principal disadvantage of this approach is its high cost. Yet the process is cumulative and even though it starts on a small scale the area protected expands with time.³⁶

Zoning is also used in the United States to prevent the conversion of farmland to nonfarm uses, though this approach is useful primarily in heavily rural communities. In Black Hawk County in northeastern Iowa, for example, the county zoning plan both preserves prime farmland and permits well-conceived residential development on land of lower agricultural productivity. Under this plan, prime farmland is defined as that which yields the equivalent of 115 bushels or more of corn per acre. On it, all residential development is prohibited.³⁷

Of course, many countries must solve more basic problems en route to resolving land-use conflicts. In some areas—in Latin America, for instance, where peasants struggle to continue ruinous cultivation on mountainsides while cattle graze in the valleys—destructive land-use systems have evolved as a result of skewed landownership patterns. Where prime cropland is in grass and where steeply sloping hillsides that should be grass are being plowed, the key to more sensible land use hinges on a reform of these feudal landholding systems.

No two countries or communities can approach land-use decisions in precisely the same way; each must work out the details of programs to preserve cropland. Yet all face the need to order priorities among competing uses. Croplands are the foundation not only of agriculture but of civilization itself. Indeed, civilization cannot survive a continuing erosion of the earth's cropland base. A world that now has over four billion human inhabitants desperately needs a land ethic, a

new reverence for land, and a better understanding of the need to use carefully a resource that is too often taken for granted.

Reforestation of the Earth

Aside from family planning, few activities can contribute more to the evolution of a sustainable society than planting trees. At mid-century, roughly one-quarter of the earth's land surface was covered by forests. By 1980 it was less than one-fifth. Each year the earth's inhabitants, all users of wood products in one form or another, increase by the equivalent of the population of Mexico and Central America combined. And each year the land in forest shrinks by an area the size of Hungary.²⁸

The demand for forest products is on the rise everywhere. The world over, wood and wood products are used to construct buildings, to make furniture, and to manufacture paper, plywood, fiberboard, and numerous other products. And with an estimated 40 percent of the world's population using wood as its primary fuel, the drain on the world's forests is immense. Surveys undertaken in Tanzania, Thailand, and elsewhere show village firewood consumption ranging from one to two tons per person annually. In industrial countries, where there has been a revival of interest in fuelwood, one of the risks is that soaring demand could lead to clear-cutting and a progressive deforestation of the sort that has plagued much of the Third World.²⁹

Although the economic role of forests is obvious, their ecological role is less well known. Among other functions, forests hold rainwater and permit it to percolate downward to recharge underground aquifers. When forest cover is stripped away, rainwater runs off quickly instead of sinking in, so water tables fall and streamflows fluctuate unpredictably. The rapid runoff in turn aggravates soil erosion, which contributes to the sedimentation of streams and reservoirs. Swollen by the combined effects of reduced water-carrying capacity and heavier runoff, rivers flood and cut new channels through the countryside.

As governments have come to recognize the multiple economic roles and ecological functions of forests, many have launched reforestation programs. Not all have succeeded. Often, the need for reforestation has been recognized too late, only after protecting new plantings from fuel-poor villagers and hungry livestock has become well-nigh impossible. In some instances, inexperienced foresters planted species that were ill-adapted to local conditions. In others, the overall approach was so poorly conceived that the people involved did not stand to benefit.

Traditional forestry is being altered by such new concepts as community participation, village woodlots, and agroforestry—the cultivation of trees, often on land unsuitable for crops. Indeed, the World Forestry Conference held in 1978 in Jakarta may well have been a turning point for the profession. At this "Forests for People" congress the Director General of the Food and Agriculture Organization (FAO), Edouard Saouma, noted that while community-based forestry was "still in its infancy," it represented an important new approach to satisfying basic human needs. He also warned the international assemblage of professional foresters that the new forestry "introduces problems which are far removed from your traditional training." In the past, foresters have worked largely with trees. Their relatively infrequent human contact was with poachers. But with the advent of community forestry, the compelling need is to work cooperatively with all those whose interests lie in the whole range of forest products.⁴⁹

In reforestation, South Korea has emerged as the model, much as Israel has become the model for desert reclamation programs. Within a decade, the face of the Korean countryside has been transformed. As recently as 1970, South Korea was a barren, denuded country plagued by soil erosion. Its hillsides were eroded, and the land had lost most of its water-retention capacity. By 1977, some 643,000 hectares (roughly half as much as the area in rice, the national food staple) had been planted to fast-growing pine trees.⁴¹

The keys to South Korea's success have been the organization of the federally linked Village Forestry Associations and the participation of

villagers in reforestation efforts. Through the association, which consists of a representative of every household, each participating village plants, tends, and harvests the local woodlots without pay. Harvested wood is distributed among households, and the proceeds from any marketable surplus are used to support other community development projects. The reforestation program's primary economic objective of producing enough firewood to satisfy the fuel needs of rural communities has been met. The economic gains are obvious to the villagers: the switch back to local wood supplies means they can now pocket the 15 percent of their income they were forced to spend on coal when firewood became scarce.

The Korean achievement is exciting. As ecological deterioration was reversed, a new national energy resource was created, all within a matter of years and through a combination of seasonally idle labor and unused land. Capital input, in the form of seedlings, was minimal; the decisive factor was the organizational technique of mobilizing villagers.

Another community forestry success story is taking place in India in the state of Gujarat. Over a decade ago the state forestry office began to see that the existing forest reserves, however skillfully managed, could not begin to satisfy local firewood needs. In 1969, under the leadership of M. K. Dalvi, the government of Gujarat launched a village woodlot-development program, planting trees on roadside strips, irrigation canal banks, and other state-owned land. The idea in each case was to let a nearby community take responsibility for managing the woodlots.⁴²

In an early evaluation, a state official, B. K. Jhala, reported that the "early roadside and canal bank plantations did not involve public participation to the degree that we hoped social forestry can achieve, but they nevertheless marked a critical psychological turning point. Seeing stands of trees arise on what had been desolate ground, people started to realize that forestry is possible around their communities and that trees can grow quickly." Among other things, these new plantations began to alter the relationship between community resi-

"The World Bank now supports community-based forestry projects along with the commercial timber ventures it has traditionally backed."

dents and forestry department officials from one of suspicion to one of cooperation.

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Once local suspicions were overcome, the number of plantations began to multiply. Erik Eckholm reports that within four years some 3,000 of the 18,000 Gujarati villages were participating in the program, and the number of villages involved continues to increase. By 1978, nine years after the project's tentative beginnings, some 6,000 of the state's 17,000 kilometers of roadway and canals were lined with young trees. Plans call for an additional 1,500 kilometers to be planted each year. Within India, Gujarat leads the way in social forestry. The model it provides serves not only for other Indian states, but for other countries as well.

In China, official figures show that the forested area expanded from 5 percent of the country in 1949 to 12.7 percent in 1978. This upturn reflects China's massive mobilization of rural labor during the off-season for reforestation and other projects to reduce flooding and soil erosion, to increase the supply of firewood in rural areas, and to produce lumber for construction and industrial uses.⁴³

Agroforestry—the third new approach to reforestation—holds great potential. Indian environmentalist Shankar Ranganathan estimates that in India alone some 40 to 50 million hectares of degraded land are suitable for agroforestry. Converting this land to forests could, he contends, provide millions of jobs and sizably increase India's gross national product. As in South Korea's reforestation campaign, such a program would combine unemployed labor with unused land to create a productive resource.⁴⁴

Governments are not alone in their efforts to reforest barren plains and denuded hillsides. International agencies, including the World Bank, the FAO, and the U.S. Agency for International Development, are also involved. The World Bank, calculating both the ecological and economic costs of deforestation, now supports community-based forestry projects along with the commercial timber ventures it has traditionally backed in Third World countries. These projects are tailored to specific conditions in individual countries. In India, South

Korea, and Malawi, the Bank is emphasizing firewood production through community woodlots and plantings in individually owned farms. In both India and Malawi, these investments have been wisely combined with a loan program for buyers of more fuel-efficient wood stoves.⁴⁵

The strength of the World Bank's commitment can be seen in its long-term lending trend. Between 1968 and 1977, forestry lending increased roughly tenfold, from about \$10 million to \$100 million per year. Another fivefold increase is expected between 1979 and 1983, by which time Bank-sponsored forestry projects should be under way in some 40 to 50 Third World countries.⁴⁶

Both governments and scientific organizations are carrying out research to identify the species with the greatest potential for reforestation in the neediest regions. A single promising possibility—the plant family Leguminosae—contains some 18,000 different species of legumes, only about 20 of which are widely cultivated. One of these, *Leucaena leucocephala*, or ipil-ipil, is now widely planted in the Philippines. These trees can reach the height of a three-story building in two years and a six-story building in just six to eight years, and they can produce 30 to 50 cubic meters of wood per hectare annually. In addition, their nitrogen-rich leaves provide nutritious forage for cattle and an excellent compost for crops.⁴⁷

The changing face of forestry entails not only a new approach to planting trees, but a wiser use of existing forests as well. In the United States, for example, many forests in New England and Appalachia are not harvested at all. Nationwide, only a small share of the forested area, much of it privately owned, is managed to maximize its yield. Harvesting neglected forests that are not reserves, parks, or protected wildlife habitats and maximizing sustainable yields will lessen pressure on forests everywhere, particularly in the Third World.⁴⁸

However successfully forests are planted and however carefully they are managed, a stable balance between people and forests cannot be restored by reforestation efforts alone. But combined with the use of

more efficient wood stoves, the adoption of paper-recycling programs, and the spread of family planning services, these exciting new initiatives in forestry can reestablish this resource.

Moving Beyond the Throwaway Society

The throwaway society evolved when energy was cheap and raw materials were abundant and when far fewer people were competing for resources than do today. Those days are gone forever. Societies that fail to adjust to this changed relationship are likely to pay with a falling standard of living.

In modern industrial economies, materials such as metal, glass, and paper are often discarded after a single use. As a result, many of the world's high-grade ores are being exhausted, urban waste disposal sites are becoming scarce, and pollution is exceeding tolerance levels in many communities.

Throwing away materials after a single use also means throwing away energy. Conversely, recycling materials increases an economy's energy efficiency and health. Consider a few examples of the savings possible. The energy required to recycle aluminum is only 4 percent of that required to produce it from bauxite, the original raw material, while the energy required to recycle copper is only one-tenth that used to produce the copper originally. For steel produced entirely from scrap, the saving amounts to some 47 percent. Recycling newsprint saves 23 percent of the energy embodied in the product and also reduces pressure on forests: a ton of recycled newsprint saves a ton of wood, a dozen trees. Recycling glass containers saves 8 percent of the energy used in their production; reusable glass containers, of course, save far more.⁴⁹

Abandoning our throwaway mentality will also alleviate waste-disposal problems. In the United States, nearly one ton of solid waste per person is collected annually from residential, industrial, and in-

stitutional sources. At present, some 14,000 landfills and other sites on some 476,000 acres are in use. Yet even this national dump—as big as Rhode Island—isn't enough. Each year, several hundred new sites must be found to absorb the ever-swelling flow of waste.⁵⁰

Once the decision is made to repair, reuse, or recycle goods, the problem of waste should be tackled at its source in homes, offices, and factories and at large resource-recovery centers where trash is assembled. Separating materials at their source holds many advantages. In the case of paper, it keeps soilage to a minimum. Sweden, which has both a generous endowment of forest resources and a large forest-product export industry, now requires waste paper to be separated from garbage in individual homes, businesses, and offices. Source separation also encourages homeowners to keep kitchen refuse, leaves, and other organic materials aside for composting. A backyard compost heap both reduces the amount of garbage to be hauled away and provides a rich organic fertilizer for gardening. This in turn reduces the need to purchase costly energy-intensive chemical fertilizers. If used to produce vegetables, the compost heap may help shoppers reduce the frequency of trips to the supermarket during the growing season.⁵¹

Where source separation is not feasible, resource-recovery centers provide an alternative. Typical of these is one planned for Leningrad. Although the city of 4.3 million now has a facility that processes 580,000 tons of garbage per year, a new plant scheduled to be operational by 1985 will be several times larger. This approach is not, however, without its drawbacks. To be economical, such centers must be large and involve hundreds of trucks that create noise, odors, and traffic congestion.⁵²

In some of the Third World's major cities, garbage is carefully sorted by hand. In Cairo, most of the components of garbage are reused. Tin, glass, paper, plastic, rags, and bones become new implements, recycled paper, upholstery, blankets, glue and paint. In a society plagued with unemployment, this approach certainly makes more sense than building high-technology resource-recovery centers or burning waste for energy.⁵³

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Ultimately, the solution to the waste problem is to reduce the amount of materials wasted. Container legislation is one step in this direction, through either mandatory deposits on returnable bottles or absolute bans on nonreturnable containers. In the United States, according to the Environmental Protection Agency, national returnable-bottle legislation would save annually some 500,000 tons of aluminum, 1.5 million tons of steel, and 5.2 million tons of glass. These savings would in turn reduce by 46 million barrels the oil consumed in the country each year—by enough, that is, to equal eight days of U.S. oil imports at 1981 levels. Along with cutting the volume of garbage down to size, returnable-bottle legislation also reduces roadside litter. Maine, Michigan, Oregon, and other states that have passed returnable-bottle legislation all report a substantial reduction in litter.⁵⁴

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One of the most imaginative approaches to the container problem is being studied in Denmark: beverage containers could come in, say, five standard sizes, that would cover the range of common needs. If fruit juices, milk, beer, and wine came in bottles that were the same size, recovery of the materials would be greatly simplified. All bottlers would draw on a common inventory of containers, changing labels or brands with the contents. If this inventory were controlled by a countrywide computer system, transportation as well as energy used in manufacturing would be sharply reduced.⁵⁵

In an era of costly energy, the extent to which a country recycles raw materials influences its industrial strength and competitive position in the world market. In Japan, a high-strung industrial economy that must import almost all the oil it uses, the proportion of waste materials recycled jumped from 16 to 48 percent between 1974 and 1978. The automobile industry there has particularly benefited from Japan's recycling efforts. It relies on not only indigenous but also imported scrap, much of it purchased from the United States. "This year's Toyota," the quip goes, "is last year's Buick."⁵⁶

The use of recycled metal is but one of the many components in the farsighted strategy that has enabled Japan to displace the United States as the world's leading automobile producer. In contrast, the

ailing U.K. economy has made very little progress in getting consumers to recycle wastes. For steel, the portion recycled is 10 percent; for paper, an estimated 15 to 30 percent; and for glass containers, a mere 3 percent. Unlike more economically dynamic Japan, Britain still dumps close to 90 percent of all consumer waste into local landfills.³⁷

In East Germany, which imports two-thirds of its raw materials, the prices paid for metals, glass, and paper at government-run recycling centers have been increased sharply to encourage recycling. In early 1980, the price for recycled newspapers was tripled and that for old books was doubled, while the payment for a glass jar went from 5¢ to 30¢. Following the price increases, long lines formed at the country's 11,000 collection points. Now ordinary citizens will help meet the national goal of increasing self-sufficiency in raw materials and reliance on continuously recycled stocks rather than on imported virgin materials.³⁸

In environmentally conscious Norway, a deposit program introduced in 1978 encourages the recycling of automobiles. When cars are purchased, the buyers pay a \$100 refundable deposit that they can collect along with a \$100 premium at authorized resource-recovery centers when the car wears out. The success of this program is making other governments take notice.³⁹

The challenge confronting governments everywhere is the same: how to maintain and improve living standards while using less energy and material resources. The details remain to be worked out, but it is clear that consumer well-being must be related more to the quality of the existing inventory of goods and less to the rate of turnover. Pride of craftsmanship has all but disappeared in the drive to produce goods that wear out or lose their appeal quickly. Yet the engineering techniques and the materials needed to design super-durable consumer goods are at hand. In a sustainable society, durability and recycling will replace planned obsolescence as the economy's organizing principle, and virgin materials will be seen not as a primary source of material but as a supplement to the existing stock.

Conserving Energy

One key to the evolution of a sustainable society is the conservation of energy, particularly that derived from petroleum. Fortunately, as energy has become more costly, interest in conservation has intensified. ~~Indeed, the progressive lowering~~ in recent years of projected U.S. energy demand for the end of the century bears out conservation's rise from a minor household virtue to a major national economic opportunity.

Prior to the Arab oil embargo in 1973 and 1974, projections of U.S. energy consumption for the year 2000 ranged from a low of 124 quads (quadrillion BTUs) by energy analyst Amory Lovins to a high of 190 quads by the Federal Power Commission. (See Table 3.) These figures compare with a 1979 U.S. energy consumption of 78 quads. Since 1972, estimates have been consistently lowered across the spectrum, regardless of whether the analyst's bias is toward conservation or supply expansion. By 1980, Exxon was forecasting that U.S. consumption at century's end would be only 105 quads, and a branch of the Department of Energy was working on an energy-efficient demand scenario in which the United States would use only 57 quads in the year 2000, a figure that is 26 percent below 1979 consumption.⁶⁰

The potential for conserving energy in the United States is enormous, partly because the amount of waste is so large and partly because the country has the technology and engineering wherewithal to increase the economy's energy efficiency. As the eighties began, some of the organizations traditionally cautious about potential gains in energy efficiency had raised their sights dramatically. Two scenarios for U.S. energy use in 2010 sketched out by the National Academy of Sciences, for example, show a consumption as low as 58 and 74 quads—projections that only a few years ago would have been viewed as heresy.⁶¹

Even such production-oriented organizations as the National Petroleum Council, Exxon, and the Petroleum Industry Research Foundation were by 1980 saying that U.S. oil consumption would never

Table 3: Downward Drift of Projected U.S. Energy Demand in 2000

Year of Forecast	Source of Projection	High	Low
		Range	Range
		(quadrillion BTUs)	
1972	Federal Power Commission Amory Lovins, Friends of the Earth	190	124
1974	Edison Electric Institute Ford Foundation (Zero Energy Growth Scenario)	160	100
1976	Edison Electric Institute Amory Lovins	140	75
1980	Exxon Corporation U.S. Department of Energy/ Solar Energy Research Institute	105	57

Source: Adapted from Amory Lovins and updated by Worldwatch Institute

again regain its 1978 level. In early 1980, the Petroleum Industry Research Foundation projected that U.S. oil consumption would drop 5 percent during the eighties and that gasoline demand would drop by 20 percent. In 1981, gasoline and oil consumption in the US were already 10 and 15 percent, respectively, below their 1978 peaks.⁶²

These projections for the U.S. economy indicate, among other things, that the link between the gross national product and energy use is not nearly as tight as once thought. Until recently, GNP and energy use had always increased in tandem, so people wrongly assumed that the two could not be separated. But what recent experience and some of the projections show is that it is quite possible for the GNP to increase over the remainder of this century even as energy use declines.

In the United States and other industrial countries where "thinking big" has been the norm, the potential for conserving energy is almost endless. In examining the merits of manipulating production versus

"It is quite possible for the GNP to increase over the remainder of this century even as energy use declines."

manipulating conservation to achieve a satisfactory energy balance, Daniel Yergin, co-author of the Harvard Business School's *Energy Future*, notes that "it is certainly easier for the government to organize itself to do one big thing, but, alas, that is not what productive conservation is about. It involves 50,000 or 50 million things, big, medium, and little, and not in the one centralized place where the energy is produced, but in the decentralized milieu where it is consumed."⁶³

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Although the US may have the greatest potential for energy conservation, other industrial countries can also benefit from conservation programs. A summary of energy policies in the OECD countries notes that by the 1985-90 period some countries might be able to save more than 10 percent of the energy now consumed per unit of industrial output. In the residential commercial sector 40 percent of the energy used in existing buildings could be saved through conservation measures, and well-built new buildings might actually use less than half the energy that present structures do. Improving automobile fuel efficiency could cut fuel consumption by 10 to 20 percent.⁶⁴

In the Third World, extolled in early literature on the world energy crisis as frugal because it had such low energy use per capita, the energy problem has different dimensions. But in character it is much the same—wasteful. A large share of the primary energy used in the Third World is lost, principally in the inefficient use of fuelwood for cooking. Indeed, according to some estimates as much as 90 percent of the energy used for cooking in the Third World is wasted. Doing nothing more than shifting food preparation from an open fire to a closed, more efficiently designed cook stove made of local materials could halve the use of firewood.⁶⁵

In both the developing and the industrial worlds, energy conservation takes two forms. The first approach is simply to perform present activities more efficiently. For example, a building can be heated to a given temperature but with less energy by insulating it. The second approach is to curtail some activities—driving less, for example. There are many opportunities to apply a combination of these approaches.

To encourage either of these approaches to conservation, governments rely on three public policy tools: information or exhortation, financial incentives or disincentives, and regulations. The first involves encouraging constructive action by providing people with facts they need to make sensible social and financial decisions. Energy efficiency labels on appliances and cars can help people make choices. Even houses could be labeled; as University of California Professor Arthur Rosenfeld has pointed out: "The marketplace responds in a fragmented industry slowly. It needs labels. It needs inspection. It needs information programs. The consumer needs to believe that when he is buying something it will work."⁶⁶

A second step governments can take is to use financial incentives or disincentives. The high tax on gasoline, which exceeds \$1 a gallon in some West European countries, has effectively discouraged the purchase and manufacture of gas-guzzling automobiles. By the same token, the efficiency of the existing automobile fleets in the United States and Canada, where the gasoline tax is trivial by comparison, leaves much to be desired.

Some of the most impressive energy savings have occurred as a result of regulations. The most visible example in the United States is probably the regulatory effort to save automobile fuel. Both the fuel-efficiency standards for American automobiles and the 55-mile-per-hour speed limit have contributed to hefty savings in gasoline. The Japanese have also applied mandatory fuel-efficiency standards to hold down gasoline consumption.

As energy supplies tightened, governments began to establish a variety of conservation goals. In some sectors, such as transportation, buildings, and household appliances, governments can set energy-efficiency standards. In the United States, the Energy Policy and Conservation Act of 1975 laid out a timetable for increasing the average fuel efficiency of new automobiles that would raise the fleet average from some 14 miles per gallon in 1974 to 27.5 by 1985. By the late seventies reluctant automobile manufacturers began producing cars that were more fuel-efficient. Their design efforts were spurred by higher gasoline prices and competition from more-efficient

imported automobiles, so that by early 1982 the fuel efficiency of American-made cars already far exceeded the original target. Other countries, including Australia, Canada, Sweden, and the United Kingdom, have outlined voluntary fuel-economy goals to encourage the production of increasingly efficient cars.⁶⁷

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Efficiency standards can also be applied to buildings. In early 1982, Congress, the U.S. Department of Energy, and the building industry were still debating plans to issue energy-efficiency standards for buildings. But even much-needed Building Energy Performance Standards will not help the existing stock. Since on the average it takes close to a century for building stock to be completely replaced, large short-term gains in the thermal efficiency of current structures can be achieved only through retrofitting. Incentives for this have been offered by national programs that include grants and loans. Canada, the Netherlands, Sweden, and West Germany now apply such programs to pre-1960 buildings at least and in some cases to the entire building stock.⁶⁸

Physicists Robert H. Williams of Princeton and Marc H. Ross of the University of Michigan believe that the amount of fuel used for space heating in the United States could be halved if relatively simple improvements were made in buildings, innovative financing procedures were adopted, and realistic economic criteria set forth. They propose an all-out campaign to increase the thermal efficiency of housing by installing storm windows, wall and floor insulation, extra attic insulation, and other weatherization measures. Using life-cycle costing techniques, they calculate that many such investments are now financially attractive.⁶⁹

Williams and Ross also recommend that the nation's housing stock be systematically audited, and they lament the scarcity of trained energy auditors or "house doctors" to take on the job. The two physicists contend that building owners generally do not have the financial information they need to make wise investments in conservation or to design an optimal housing retrofit. Since simple "hole plugging" and relatively straightforward architectural modifications can eliminate

most substantial heat losses, following the advice of Williams and Ross amounts to substituting intelligence for oil.

Energy-efficiency standards for appliances ought to be another high priority, given that refrigerators, stoves, water heaters, clothes dryers, furnaces, air conditioners, and the like account for 75 percent of all residential energy use. In the United States, preliminary standards were issued in mid-1980. At that time Assistant Secretary of Energy Thomas Stelson estimated that the equivalent of 4.28 billion barrels of oil would be saved by 2005 if the preliminary standards took hold immediately and were fully phased in by early 1986. Unfortunately, the standards have been weakened by the new administration, and their effect is likely to be reduced considerably.⁷⁰

Critical as efficiency standards are, they represent only one small part of the conservation potential. Indeed, one reason projected U.S. energy demand has been dropping so dramatically is that the various efforts to conserve energy reinforce each other, acting as conservation "multipliers." For example, in a matter of years fuel-efficiency standards could double the number of miles cars get per gallon at a time when car pooling could raise the average number of occupants in an automobile from 1.4 to 2.0.⁷¹ If at the same time people become more conscious of commuting distances as they establish residences and accept jobs so that the distance they drive declines, fuel use could drop faster still. Indeed, if increased mileage efficiency results in savings of 50 percent, higher automobile-occupancy rates in savings of 20 percent, and a greater proximity to work in savings of 5 percent—all reasonable assumptions—automobile fuel consumption could drop by a phenomenal 62 percent. And this could be achieved without any voluntary curtailment of driving or shifts to more fuel-efficient public transport.

Residential heating and cooling is just as ripe for the efficiency "multiplier effect" as transportation is. For example, insulating a house to increase its thermal efficiency can reduce the heating and cooling requirements by 40 percent. Installing a day/night thermostat can reduce fuel requirements by 10 percent, and turning off the heat and air conditioning in an unused guest room, another 10 percent. Together,

"One reason projected U.S. energy demand has been dropping so dramatically is that various efforts to conserve energy reinforce each other, acting as conservation 'multipliers.'"

these reductions—none of which is at all outlandish—could halve residential heating and cooling requirements.

The potential contribution of modern technology and engineering know-how to energy conservation has scarcely been tapped. There are already standard-sized television sets, for example, that use less electricity than a 60-watt light bulb does, and some modern office buildings are so thermally efficient that interior lighting and the body heat of their occupants provide all the space heating needed. Prototypical automobiles travel 80 miles per gallon of fuel.⁷² These energy-savers represent the first offspring of the promising applied science of conservation and the embodied hope that advanced technology can be substituted for energy.

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Developing Renewable Energy

Most of the world's readily accessible, remaining reserves of petroleum will be consumed within a few decades, yet the development of new energy sources to power the economy is far behind schedule. The potential depletion of oil reserves before alternatives are developed poses a major challenge to the global economic system.

Although petroleum's replacements are not on tap yet, at least the choices are narrowing. Coal, while it can help in the near term, is ultimately like oil: exhaustible. Its remaining reserves are greater, but so are the economic and environmental costs attached to its use. Nuclear power, once projected to be the long-term replacement for oil, holds little promise. In the United States, the world's leading producer of nuclear power, the obituary is being written by Wall Street, which has all but abandoned the industry. The answers to the energy needs of sustainable societies appear increasingly to lie in the many forms of renewable energy.

New technologies and adaptations of traditional ones permit renewable energy to be harnessed in innumerable ways. Solar energy can be captured directly through such devices as windmills, hydroelectric

generators, rooftop collectors, photovoltaic cells, and buildings that incorporate solar architecture or indirectly through forests, fuelwood plantations, and energy crops. In addition, geothermal energy holds great promise.

Interest in renewable energy is being spurred by several economic considerations beyond the obvious need to lessen the impact of rising oil prices. First, since renewable resources are largely indigenous, the outlays of foreign exchange are often nonexistent or negligible, limited to those for imported equipment or technical advice. Second, many renewable energy sources are virtually inflation proof. Once the initial investment is made, the cost of running a hydroelectric dam or a solar water heater is independent of rising fuel prices.

In employment terms, too, renewables are attractive. Most require less capital and create more jobs than fossil fuels or nuclear power do. In this respect, the timing of the transition from fossil fuels to renewable energy could not be more fortuitous, coming as it does when unemployment is high and record numbers of young people will be entering the job market.

Another advantage is that time lags in the development of renewable energy resources are shorter than for most types of energy. Turning to wood in a heavily forested area takes no more time than that required to purchase a wood stove or, in the case of industry, a wood-fired boiler. A methane generator can be built in days. A small-scale hydro facility can be constructed with seasonally unemployed labor in a matter of months. Exceptions to this short lead time include large-scale hydroelectric projects, which can take many years, and firewood plantations, which can require close to a decade before harvesting can begin. But overall, renewable resources can be developed extraordinarily rapidly, as the recent experience with wood fuel in the United States, small hydropower in China, and energy crops in Brazil has shown.

In some cases, rapid development of a given renewable energy source requires commercial mass production of some machinery. For exam-

ple, the key to rapid growth in wind-generated electricity will be the mass production of wind generators. With at least two wind farms already operating in the United States and with generators scheduled for large-scale factory production in 1982, the stage is being set for rapid exploitation of this abundant energy source. Fortunately, the technologies required to develop renewable energy resources are often closely related to existing, well-understood processes. In the case of wind generators, the engineering and aerodynamics are similar to those employed in the aerospace industry. Similarly, the knowledge of deep drilling and geology brought to bear in oil exploration and production can easily be modified for geothermal development. Indeed, oil companies frequently discover geothermal resources when drilling for petroleum.⁷³

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Of the various renewable energy technologies, the one whose future depends most heavily on further advances is photovoltaics. Unless costs are reduced substantially, the use of solar cells will be limited to special situations, mostly in remote sites. But if the costs drop to the point at which electricity from photovoltaic cells becomes competitive with electricity from conventional systems—the goal of both U.S. and Japanese R&D efforts—then solar cells could make quite a contribution to world energy supply, particularly where electrical grids do not exist.

Each country's energy-development strategy must be tailored to its indigenous endowment of renewable resources. And while no two countries are in precisely the same situation, no nation is without solar potential. Some countries may end up relying heavily on a single, locally abundant form of solar energy; others may have highly diversified renewable energy economies. For example, Nepal, Norway, and Paraguay, all richly endowed with hydroelectric potential relative to population, could rely heavily on electricity. Heavily forested countries, in contrast, could fashion an energy strategy centered around wood. For a few countries, the United States among them, the wisest course is to develop the entire panoply of renewable energy sources—wood, wind, hydro, rooftop collectors, livestock waste, energy crops, geothermal, and photovoltaics.

Among the countries moving rapidly toward a sustainable energy economy, Brazil is emerging as an early leader. Its program—aimed at eliminating most oil imports by 1990—is centered around the development of its vast hydroelectric potential, the use of wood as a residential and industrial fuel, and a fast-advancing agriculturally based alcohol fuels program. With a pauper's endowment of fossil fuels and its on-ambitious nuclear program in arrears, Brazil is building an industrial economy based almost entirely on renewable energy. To ensure success, Brazil could take better advantage of its hydroelectric potential by relying less on the automobile and more on electrically powered urban and inner-city rail systems. This would reduce liquid fuel requirements and thus lessen the competition between the transport and food sectors for food-producing resources. At the same time, Brazil urgently needs to curb population growth; if it does not, the favorable resource/population balance that gives it so many energy options will disappear.⁷⁴

China too has moved vigorously to develop renewable energy resources—less because the country lacks fossil fuels than because it lacks the transportation infrastructure, investment capital, and technologies needed to exploit them. China's efforts have centered upon the construction of small-scale hydroelectric generating systems in rural areas, the production of methane from organic wastes, and an ambitious village reforestation program designed to ensure a long-term supply of fuelwood. Alone, none of these programs will dominate China's overall energy picture in the future, but together they already dominate energy systems in many rural areas. And they provide some leeway for the country to develop its large hydroelectric potential.⁷⁵

Under the pressure of near total dependence on imported oil, the Philippine Government designed an ambitious ten-year energy program aimed at reducing oil's contribution to the national energy budget from 91 percent to 56 percent by 1989. Although coal and nuclear power are expected to account for some 15 percent of total commercial energy use by then, renewable sources—including hydroelectric, geothermal electric, wood, agricultural wastes, timber-indus-

"Many renewable energy sources are frequently omitted from projections of world energy use because data often do not exist."

try wastes, and fuel alcohol from sugarcane—could push the renewable share of total energy use to one-third by the end of the ten years.⁷⁶

So far, none of the advanced industrial countries is as far along in implementing renewable energy programs as Brazil and China are. Yet Sweden, almost wholly dependent on imports for oil, is considering a way to wean its economy from fossil fuels and nuclear power by exploiting its forest resources and abundant wind-generating potential—even as Swedish energy consumption increases overall by an estimated 50 percent. In the United States, President Carter announced in 1978 that the country would try to obtain 20 percent of its energy from various solar sources by the end of the century. Developments since then, including the 1979 oil price hike and the lack of new reactor orders by utilities, suggest that the solar share could be substantially higher. Although the Reagan administration has abandoned the 20 percent goal, conservation efforts continue to reduce total oil consumption and the shift to renewable energy sources is accelerating. The use of fuelwood for residential and industrial purposes, for example, is rising far more rapidly than the Carter administration projected. Indeed, in the United States firewood now contributes nearly twice as much as delivered energy as nuclear power does.⁷⁷

An initial effort to estimate the worldwide use of renewable energy in 1980 and to project its consumption to the end of the century shows renewable sources now supplying the energy equivalent of 1.8 billion tons of coal. (See Table 4.) Wood and hydropower, currently the world's leading forms of renewable energy, rank fourth and fifth in the global energy budget after oil, coal, and natural gas. Yet despite this important contribution many renewable energy sources are frequently omitted from projections of world energy use because data on their abundance and availability often do not exist. For example, using rooftop collectors to heat water is not a commercial transaction, so this form of solar energy does not show up in national economic accounts. Likewise, much of the world's firewood is produced and gathered in subsistence economies without ever entering the marketplace. And hundreds of cities now use garbage to generate electricity, but no readily available worldwide data exists yet on the quantity of combustible waste used in this way.

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Table 4: World Consumption of Energy from Renewable Sources, 1980, with Projections to 2000*

Source	1980	1985	1990	1995	2000
(million metric tons coal equivalent)					
Wood	1,015	1,100	1,220	1,410	1,640
Hydroelectric	600	710	850	1,020	1,200
Wind	3	5	17	90	200
Crop Residues	100	110	110	100	100
Waste—methane	4	10	30	53	90
Waste—electric & steam	10	12	15	20	25
Geothermal	13	27	52	87	140
Energy Crops	3	16	30	45	55
Solar Collectors	1	5	18	49	100
Cow Dung	57	60	60	55	45
Photovoltaics	0	0	2	20	40
Total	1,806	2,055	2,404	2,949	3,635

*Electricity from all sources calculated in terms of coal required to produce equivalent amount.

Source: Worldwatch Institute.

Over the next two decades, growth in the solar component of the global energy budget will stand out. (See Table 5.) By the year 2000, the contribution of all solar energy sources is expected to exceed that of petroleum, although within individual countries the situation will vary widely. The rate at which renewables are developed will depend on how quickly national governments can evaluate and exploit their indigenous resources. As of 1981, only a few have plans for a smooth transition from the use of fossil fuels to dependence on renewable sources of energy. Legislation and financial incentives will play an important role. One example in the United States is the Public Utilities Regulatory Policies Act of 1978, which requires utilities to buy power generated by small systems at the cost required to generate that energy from new sources. The Natural Resources Defense Council reports that "homes or businesses that generate power from renewable resources such as hydropower, biomass, wind, and from cogenera-

Table 5: World Consumption of Energy, Nonrenewable and Renewable, 1980, with Projections to 2000*

Year	Coal	Petroleum	Natural Gas	Nuclear	Renewables	Total
(million metric tons coal equivalent)						
1980	3,149	3,908	1,807	244	1,806	10,914
1985	3,831	3,810	1,850	445	2,055	11,992
1990	4,660	3,712	1,900	645	2,404	13,321
1995	5,145	3,526	1,875	720	2,949	14,215
2000	5,680	3,322	1,850	730	3,635	15,217

*Electricity from all sources calculated in terms of coal required to produce equivalent amount

Source: Worldwatch Institute

tion facilities or photovoltaic equipment will be able to sell back excess power to their local utility at reasonable rates."⁷⁸

The development of renewable energy resources could also be accelerated by negative findings about the use or production of other energy sources. If burning more coal increases pollution and the damage caused by acid rain, coal could become an unacceptable energy source. If a safe way is not found to dispose of nuclear wastes, the various renewable options will become even more attractive. Of course, realizing and maximizing the renewable energy potential will mean that difficult trade-offs will have to be made. If the world's hydro potential is to become a mainstay of a sustainable economy, it may be necessary to compromise on wilderness preservation, at least enough to permit this energy source to be tapped. If Japan is to develop its vast geothermal potential, it may have to relax its restrictions on energy development in its national parks, which are situated where the potential is greatest.

The critical dimension of the global energy transition is time. The challenge is to use coal to supplement dwindling oil reserves, thus buying time to develop the earth's hydroelectric and geothermal po-

tential, to plant community woodlots, to install solar collectors, to produce enough electric wind generators, to build methane generators, to plant energy crops, and to develop the many other renewable energy resources—all while designing a more energy-efficient economic system.

As the switch from fossil fuels to solar energy progresses, the geographic distribution of economic activity is destined to change, conforming to the location of new energy sources. The increasing use of renewable energy promises to redistribute populations and alter modes of transportation. People and industrial activity will be more widely dispersed, far less concentrated in urban agglomerations than they are in a petroleum-fueled society. The renewable energy economy seems likely to alter rural-urban relationships within countries and the competitive position of national economies in the world market.

The transition to renewable energy will endow the global economy with a permanence that coal- and oil-based societies lack. More than that, it could lead us out of an inequitable, inherently unstable international energy regime because—unlike coal and oil—solar energy is diffuse, available in many forms, and accessible to all countries.

Conclusion

The transition to a sustainable society will challenge the capacity of countries everywhere to change and adapt. Some adjustments will occur in response to market forces, some in response to public policy changes, and still others as a result of voluntary changes in lifestyles. In order to take the necessary steps, all nations will have to make major financial commitments as soon as possible.

Building a sustainable society will require heavy investments, both public and private, simultaneously in several sectors. Funds are needed to construct soil-conserving terraces, install rooftop solar collectors, build fuel-efficient mass-transit systems, and take thousands of other steps. Once the transition is well under way, invest-

"As the switch to solar energy progresses, the geographic distribution of economic activity is destined to change, conforming to the location of new energy sources."

ment requirements will fall sharply. But until then, capital will be scarce and costly.

Although most national political leaders at least acknowledge the threat of continued population growth, few governments have adequately funded either population education or family planning programs. Despite the overwhelming influence of future population increases on the human prospect, half the world's couples lack ready access to family planning services. The International Conference on Family Planning in the Eighties, which met in Jakarta in early 1981, estimated that \$3 billion will be needed annually to meet population and family planning program needs, compared with roughly \$1 billion currently being spent. Nationally, few governments have yet launched effective population education programs—programs that explain the urgency of halting population growth.⁷⁹

One of the most troubling investment gaps is that in efforts to protect the world's cropland—both eliminating excessive soil erosion and halting the conversion of prime cropland to nonfarm uses. Few governments have fully recognized this dual threat to future food supplies, much less translated such awareness into budgetary commitments. Farmers need to make heavy investments in soil protection practices, but without governmental cost-sharing, the world's soils will continue to deteriorate. As this becomes clearer, soil conservation programs are likely to become a major budget item. Official estimates indicate that adequate protection of U.S. croplands will require at least a doubling of public expenditures on this activity. Many Third World countries need a severalfold increase in investments in soil-saving measures.⁸⁰

With reforestation, the financial resources are grossly inadequate. Only a handful of Third World countries have made a solid commitment in this sector despite the obvious imperatives to do so. In contrast, the United States, which by international standards is generously endowed with forests, pledged funds in its 1981 budget to reforest 460,000 acres. Fortunately, international aid agencies are increasing sharply their investment in reforestation during the eighties. Since 1978, the U.S. Agency for International Development and the World

Bank support of village firewood plantations has increased some tenfold over the preceding decade. Annual lending for forestry projects by the Bank alone is expected to reach \$500 million by 1985. Even so, vast gaps remain. The Bank estimates, for example, that in sub-Saharan Africa reforestation efforts would have to expand some 15-fold just to meet future fuelwood needs.⁸¹

Substantial amounts of capital will be needed for soil conservation, reforestation, and population stabilization over the next few years, but they will be dwarfed by the energy-related investments required. All societies must search for a balance between investments in energy production and those in energy efficiency—for Third World countries, the balance may be between expenditures to produce more firewood and those to produce more fuel-efficient wood stoves. In industrial societies, trade-offs will be between such things as producing synthetic fuels and designing more fuel-efficient transport systems.

By any reckoning, taking these steps to a sustainable society will require all the investment capital that can be mustered. Indeed, realigning investment priorities to match new environmental and economic realities is one of the most urgent challenges of the transition that lies ahead. Market forces alone will not suffice; public policy choices will of necessity play a key role in guiding the transition.

In a world where economic growth is slowing and where efforts to increase savings are not meeting with much success, finding the additional investment capital needed to put society on a sustainable footing will not be easy. However unlikely it may now appear, the only way to secure the needed capital may be to shift budgetary funds from the military sector. Without a reduction in the \$550-billion global military budget, the capital for a smooth and timely transition may not be available. Governments will be forced to weigh carefully the trade-off between reductions in military expenditures and possible declines in living standards for their people.

A vast amount of scientific talent must also be diverted from the military sector—to develop the renewable energy resources to replace oil, to devise resource management techniques that will protect the earth's

Realigning investment priorities
to match new environmental
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biological systems, and to develop agricultural practices that will protect the soils. A global R&D budget that now allocates more to the development of new weapons than it does to new energy systems and techniques for increasing food production combined may preclude the evolution of a sustainable society.

The intensifying economic and social stresses of the early eighties reflect values and priorities that no longer mesh with the unfolding environmental and resource realities. As circumstances change, values must change accordingly. When they do not, societies do not long endure. Values, then, are the key to the evolution of a sustainable society, not only because they influence behavior, but also because they determine a society's priorities and thus its ability to survive.

Ironically, some of the values needed to ensure human survival over the last few million years, such as acquisitiveness or the desire for many children, are precisely those that now threaten survival. Continuous childbearing by women throughout their reproductive life span was undoubtedly a key factor in the survival of the species, but now circumstances have changed, and so must desired family size. Acquisitiveness, too, may have served humans well in earlier times, when the margin of survival was thin, but today it has been translated into a form of materialism that has supplanted more profound social ethics—those posited on survival, personal growth, and ecological harmony. In many cases, the acquisition of material goods has passed the point where there is any direct relationship to human need.

Our concepts of national security are destined to change. The traditional military concept of "national security" is growing ever less adequate as nonmilitary threats grow more formidable. These threats to security arise not from the relationship of nation to nation but from the relationship of humanity to nature.

Values and priorities do not change in a vacuum. They change only as people's perceptions of reality change. New analyses and new information play an essential role in the evolution of values and in the reordering of priorities. Only as governments realize that the current

overwhelming emphasis on military expenditures may shortly lead to a decline in living standards will they become interested in shifting their investment priorities.

Information on the changing population/resource relationship can play a key role in such changes. China is a case in point: the broad acceptance of family planning and the one-child-family goal was the result of the widespread government effort to make information available on the relationship between population growth and future well-being. The calculations of future cropland/population balances successfully shifted the focus of attention in childbearing decisions from the welfare of today's parents to that of their children.⁸²

Analyses such as *The Global 2000 Report to the President*, published in the United States in 1980, provide information on global population and resource trends and a useful backdrop for policymaking.⁸³ What is now needed are "National 2000 Reports" that will enable individual countries to project the relationship between their population and their resources, including energy (both nonrenewable and renewable), water, forests, grasslands, cropland, and food. Such studies can be of immeasurable value in altering values and reordering priorities.

Efforts to put society on a sustainable footing will tax the capacity of individuals and institutions everywhere to change and adapt to the new circumstances. Some forward-looking countries with effective leadership will adjust in time to avoid severe economic and social stresses. Others will learn the hard way.

Taking part in the creation of a sustainable society will be an extraordinarily challenging and satisfying experience, enriched by a sense of excitement that our immediate forebearers who built fossil-fuel-based societies did not have. The excitement comes from both the vast scale of the undertaking and the full knowledge of the consequences of failure.

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Worldwatch Institute
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036 USA

LESTER R. BROWN is President of and a Senior Researcher with Worldwatch Institute. Formerly Administrator of the International Agricultural Development Service of the United States Department of Agriculture, he is the author of several books, including *World Without Borders*, *By Bread Alone*, *The Twenty-Ninth Day*, and *Building a Sustainable Society* (W. W. Norton, October 1981).

PAMELA SHAW is a Researcher with Worldwatch Institute, where she is working on agriculture and human resources.