

Overview

The achievement of sustained and equitable development remains the greatest challenge facing the human race. Despite good progress over the past generation, more than 1 billion people still live in acute poverty and suffer grossly inadequate access to the resources—education, health services, infrastructure, land, and credit—required to give them a chance for a better life. The essential task of development is to provide opportunities so that these people, and the hundreds of millions not much better off, can reach their potential.

But although the desirability of development is universally recognized, recent years have witnessed rising concern about whether environmental constraints will limit development and whether development will cause serious environmental damage—in turn impairing the quality of life of this and future generations. This concern is overdue. A number of environmental problems are already very serious and require urgent attention. Humanity's stake in environmental protection is enormous, and environmental values have been neglected too often in the past.

This Report explores the two-way relationship between development and the environment. It describes how environmental problems can and do undermine the goals of development. There are two ways in which this can happen. First, environmental quality—water that is safe and plentiful and air that is healthy—is itself part of the improvement in welfare that development attempts to bring. If the benefits from rising incomes are offset by the costs imposed on health and the quality of life by pollution, this cannot be called development. Second, environmental damage can undermine future productivity. Soils that are degraded, aquifers that are depleted, and ecosystems that are destroyed in the name of raising incomes today can jeopardize the prospects for earning income tomorrow.

The Report also explores the impact—for good and bad—of economic growth on the environment. It identifies the conditions under which policies for efficient income growth can complement those for environmental protection and identifies tradeoffs. Its message is positive. There are strong “win-win” opportunities that remain unex-

ploited. The most important of these relates to poverty reduction: not only is attacking poverty a moral imperative, but it is also essential for environmental stewardship. Moreover, policies that are justified on economic grounds alone can deliver substantial environmental benefits. Eliminating subsidies for the use of fossil fuels and water, giving poor farmers property rights on the land they farm, making heavily polluting state-owned companies more competitive, and eliminating rules that reward with property rights those who clear forests are examples of policies that improve both economic efficiency and the environment. Similarly, investing in better sanitation and water and in improved research and extension services can both improve the environment *and* raise incomes.

But these policies are not enough to ensure environmental quality; strong public institutions and policies for environmental protection are also essential. The world has learned over the past two decades to rely more on markets and less on governments to promote development. But environmental protection is one area in which government must maintain a central role. Private markets provide little or no incentive for curbing pollution. Whether it be air pollution in urban centers, the dumping of unsanitary wastes in public waters, or the overuse of land whose ownership is unclear, there is a compelling case for public action. Here there may be tradeoffs between income growth and environmental protection, requiring a careful assessment of the benefits and costs of alternative policies as they affect both today's population and future generations. The evidence indicates that the gains from protecting the environment are often high and that the costs in forgone income are modest if appropriate policies are adopted. Experience suggests that policies are most effective when they aim at underlying causes rather than symptoms, concentrate on addressing those problems for which the benefits of reform are greatest, use incentives rather than regulations where possible, and recognize administrative constraints.

Strong environmental policies complement and reinforce development. It is often the poorest who suffer most from the consequences of pollution

Box 1 Development and the environment: key messages of this Report

The protection of the environment is an essential part of development. Without adequate environmental protection, development is undermined; without development, resources will be inadequate for needed investments, and environmental protection will fail.

The coming generation presents unprecedented challenges and opportunities. Between 1990 and 2030, as the world's population grows by 3.7 billion, food production will need to double, and industrial output and energy use will probably triple worldwide and increase fivefold in developing countries. This growth brings with it the risk of appalling environmental damage. Alternatively, it could bring with it better environmental protection, cleaner air and water, and the virtual elimination of acute poverty. Policy choices will make the difference.

Priorities for action

Inadequate attention has been given to the environmental problems that damage the health and productivity of the largest number of people, especially the poor. Priority should be given to:

- The one-third of the world's population that has inadequate sanitation and the 1 billion without safe water
- The 1.3 billion people who are exposed to unsafe conditions caused by soot and smoke
- The 300 million to 700 million women and children who suffer from severe indoor air pollution from cooking fires
- The hundreds of millions of farmers, forest dwellers, and indigenous people who rely on the land

and whose livelihoods depend on good environmental stewardship.

Addressing the environmental problems faced by these people will require better progress in reducing poverty and raising productivity. It is imperative that the current moment of opportunity be seized to bring about an *acceleration* of human and economic development that is sustained and equitable.

Policies for sustained development

Two types of policies are required: those that build on the positive links between development and the environment, and those that break the negative links.

Building on the positive links

The scope for actions that promote income growth, poverty alleviation, and environmental improvement is very large, especially in developing countries. Such "win-win" policies include:

- Removing subsidies that encourage excessive use of fossil fuels, irrigation water, and pesticides and excessive logging
- Clarifying rights to manage and own land, forests, and fisheries
- Accelerating provision of sanitation and clean water, education (especially for girls), family planning services, and agricultural extension, credit, and research
- Taking measures to empower, educate, and involve farmers, local communities, indigenous people, and women so that they can make decisions and investments in their own long-term interests.

and environmental degradation. Unlike the rich, the poor cannot afford to protect themselves from contaminated water; in cities they are more likely to spend much of their time on the streets, breathing polluted air; in rural areas they are more likely to cook on open fires of wood or dung, inhaling dangerous fumes; their lands are most likely to suffer from soil erosion. The poor may also draw a large part of their livelihood from unmarketed environmental resources: common grazing lands, for example, or forests where food, fuel, and building materials have traditionally been gathered. The loss of such resources may particularly harm the poorest. Sound environmental policies are thus likely to be powerfully redistributive.

Making decisions about some environmental problems is complicated by uncertainties about physical and ecological processes, by the long-term nature of their effects, and by the possibility

of thresholds beyond which unexpected or irreversible change may occur. New evidence that the impact of chlorofluorocarbons (CFCs) on stratospheric ozone depletion is greater than earlier thought is a timely reminder of how little we know. Such uncertainties call for much greater attention to research and to designing flexible precautionary policies.

Because this Report is about development and the environment, it focuses primarily on the welfare of developing countries. The most immediate environmental problems facing these countries—unsafe water, inadequate sanitation, soil depletion, indoor smoke from cooking fires and outdoor smoke from coal burning—are different from and more immediately life-threatening than those associated with the affluence of rich countries, such as carbon dioxide emissions, depletion of stratospheric ozone, photochemical smogs, acid rain,

Targeted environmental policies

But these "win-win" policies will not be enough. Also essential are strong policies and institutions targeted at specific environmental problems. Lessons for effective policymaking include the following:

- Tradeoffs between income and environmental quality need to be carefully assessed, taking long-term, uncertain, and irreversible impacts into account. Carefully balancing costs and benefits is especially important for developing countries, where resources are scarce and where basic needs still must be met.
- Standards and policies need to be realistic and consistent with the monitoring and enforcement capacity and the administrative traditions of the country.
- Blunter and more self-enforcing policies are likely to be attractive in developing countries. Policies need to work with the grain of the market rather than against it, using incentives rather than regulations where possible.
- Governments need to build constituencies for change—to curb the power of vested interests, to hold institutions accountable, and to increase willingness to pay the costs of protection. Local participation in setting and implementing environmental policies and investments will yield high returns.

The costs of a better environment

The costs of protecting and improving the environment are high in absolute terms, but they are modest in comparison with their benefits and with the potential gains from economic growth. Improving the environment for development may make it necessary to raise invest-

ment rates in developing countries by 2-3 percent of GDP by the end of this decade. This would enable stabilization of soil conditions, increased protection of forests and natural habitats, improved air and water quality, a doubling of family planning expenditures, sharply improved school enrollment rates for girls, and universal access to sanitation and clean water by 2030. The costs of addressing global atmospheric issues would be additional.

Partnership for solutions

Finding, implementing, and financing solutions will require a partnership of effort among nations. Specifically:

- Improved know-how, new technologies, and increased investment are essential. Open trade and capital markets, the restoration of creditworthiness through policy reform and selective debt relief, and robust, environmentally responsible growth in the world economy will all be needed.
- The close link between poverty and environmental problems makes a compelling case for increasing assistance to reduce poverty and slow population growth and for addressing environmental damage that hurts the poor.
- High-income countries must play a major role in financing the protection of natural habitats in developing countries from which the whole world benefits. They must also assume the primary responsibility for addressing worldwide problems of which they are the primary cause (greenhouse warming and depletion of stratospheric ozone).

and hazardous wastes. Industrial countries need to solve their own problems, but they also have a crucial role to play in helping to improve the environments of developing countries.

- First, developing countries need to have access to less-polluting technologies and to learn from the successes and failures of industrial countries' environmental policies.
- Second, some of the benefits from environmental policies in developing countries—the protection of tropical forests and of biodiversity, for example—accrue to rich countries, which ought therefore to bear an equivalent part of the costs.
- Third, some of the potential problems facing developing countries—global warming and ozone depletion, in particular—stem from high consumption levels in rich countries; thus, the burden of finding and implementing solutions should be on the rich countries.

- Fourth, the strong and growing evidence of the links between poverty reduction and environmental goals makes a compelling case for greater support for programs to reduce poverty and population growth.

- Fifth, the capacity of developing countries to enjoy sustained income growth will depend on industrial countries' economic policies; improved access to trade and capital markets, policies to increase savings and lower world interest rates, and policies that promote robust, environmentally responsible growth in industrial countries, will all help.

Policy reforms and institutional changes are required to bring about accelerated development and better environmental management. The obstacles are great. Nevertheless, the present time is unprecedented in its potential for change. The growing recognition of the importance of environ-

mental concerns, the rapid introduction of economic reform programs around the world, and the trend toward democratization and participation in the development process all point in the right direction. The United Nations Conference on Environment and Development (UNCED)—the “Earth Summit”—in June 1992 has provided an opportunity for the world’s nations to commit themselves to an agenda of reform. It is essential that the energies that have been unleashed by UNCED not be dissipated but rather be channeled toward addressing those environmental problems that most urgently threaten development.

Focusing on the right problems

This Report makes no attempt to be comprehensive in its discussion of environmental problems. Rather, it seeks to identify the most serious challenges and suggests strategies for addressing them. Not every problem can be a priority for every country. Taking the view that the highest environmental priorities are those that directly affect the welfare of large numbers of people, the

Report concludes that the current environmental debate has paid too little attention to the problems of sanitation and clean water, urban air pollution, indoor air pollution, and severe land degradation.

Damage to the environment has three potential costs to present and future human welfare. Human health may be harmed. Economic productivity may be reduced. And the pleasure or satisfaction obtained from an unspoiled environment, often referred to as its “amenity” value, may be lost. All are difficult to measure, but the third is especially so. “Amenity” includes values that range from those associated with recreation to those associated with deeply held spiritual views about the intrinsic worth of the natural world. The difficulty in measuring it argues for much more public involvement in setting priorities. Table 1 outlines the potential consequences for health and productivity of different forms of environmental mismanagement. Since environmental problems vary across countries and with the stage of industrialization, each country needs to assess its own priorities carefully.

Table 1 Principal health and productivity consequences of environmental mismanagement

<i>Environmental problem</i>	<i>Effect on health</i>	<i>Effect on productivity</i>
Water pollution and water scarcity	More than 2 million deaths and billions of illnesses a year attributable to pollution; poor household hygiene and added health risks caused by water scarcity	Declining fisheries; rural household time and municipal costs of providing safe water; aquifer depletion leading to irreversible compaction; constraint on economic activity because of water shortages
Air pollution	Many acute and chronic health impacts: excessive urban particulate matter levels are responsible for 300,000–700,000 premature deaths annually and for half of childhood chronic coughing; 400 million–700 million people, mainly women and children in poor rural areas, affected by smoky indoor air	Restrictions on vehicle and industrial activity during critical episodes; effect of acid rain on forests and water bodies
Solid and hazardous wastes	Diseases spread by rotting garbage and blocked drains. Risks from hazardous wastes typically local but often acute	Pollution of groundwater resources
Soil degradation	Reduced nutrition for poor farmers on depleted soils; greater susceptibility to drought	Field productivity losses in range of 0.5–1.5 percent of gross national product (GNP) common on tropical soils; offsite siltation of reservoirs, river-transport channels, and other hydrologic investments
Deforestation	Localized flooding, leading to death and disease	Loss of sustainable logging potential and of erosion prevention, watershed stability, and carbon sequestration provided by forests
Loss of biodiversity	Potential loss of new drugs	Reduction of ecosystem adaptability and loss of genetic resources
Atmospheric changes	Possible shifts in vector-borne diseases; risks from climatic natural disasters; diseases attributable to ozone depletion (perhaps 300,000 additional cases of skin cancer a year worldwide; 1.7 million cases of cataracts)	Sea-rise damage to coastal investments; regional changes in agricultural productivity; disruption of marine food chain

Clean water and sanitation

For the 1 billion people in developing countries who do not have access to clean water and the 1.7 billion who lack access to sanitation, these are the most important environmental problems of all. Their effects on health are shocking: they are major contributors to the 900 million cases of diarrheal diseases every year, which cause the deaths of more than 3 million children; 2 million of these deaths could be prevented if adequate sanitation and clean water were available. At any time 200 million are suffering from schistosomiasis or bilharzia and 900 million from hookworm. Cholera, typhoid, and paratyphoid also continue to wreak havoc with human welfare. Providing access to sanitation and clean water would not eradicate all these diseases, but it would be the single most effective means of alleviating human distress.

The economic costs of inadequate provision are also high. Many women in Africa spend more than two hours a day fetching water. In Jakarta an amount equivalent to 1 percent of the city's gross domestic product (GDP) is spent each year on boiling water, and in Bangkok, Mexico City, and Jakarta excessive pumping of groundwater has led to subsidence, structural damage, and flooding.

Clean air

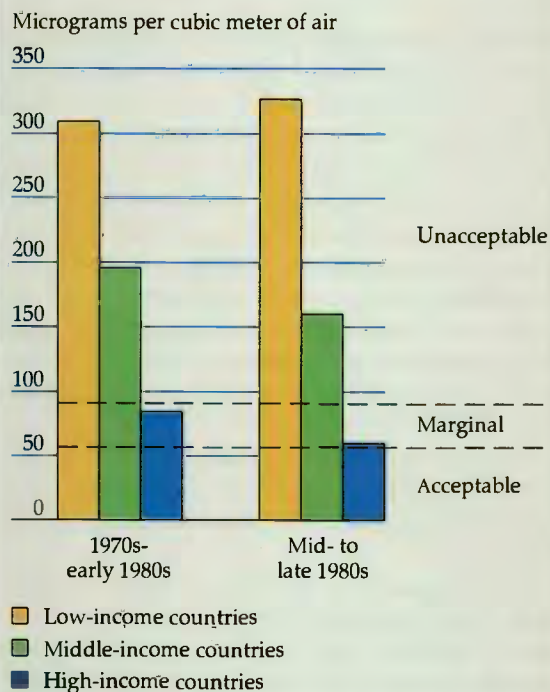
Emissions from industry and transport and from domestic energy consumption impose serious costs for health and productivity. Three specific problems stand out for their effect on human suffering.

SUSPENDED PARTICULATE MATTER. In the second half of the 1980s about 1.3 billion people worldwide lived in urban areas that did not meet the standards for particulate matter (airborne dust and smoke) set by the World Health Organization (WHO). They thus faced the threat of serious respiratory disorders and cancers (see Figure 1). If emissions could be reduced so that the WHO standards were met everywhere, an estimated 300,000 to 700,000 lives could be saved each year, and many more people would be spared the suffering caused by chronic respiratory difficulties.

LEAD. High levels of lead, primarily from vehicle emissions, have been identified as the greatest environmental danger in a number of large cities in the developing world. Estimates for Bangkok suggest that the average child has lost four or more

Soot and smoke are worsening in poor countries, improving in middle- and high-income countries

Figure 1 Urban air pollution: average concentrations of suspended particulate matter, by country income group



Note: Periods of time series differ by site. World Health Organization guidelines for air quality are used as the criteria for acceptability.

Source: Environmental data appendix table A.5.

IQ points by the age of seven because of elevated exposure to lead, with enduring implications for adult productivity. In adults the consequences include risks of higher blood pressure and higher risks of heart attacks, strokes, and death. In Mexico City lead exposure may contribute to as much as 20 percent of the incidence of hypertension.

INDOOR AIR POLLUTION. For hundreds of millions of the world's poorer citizens, smoke and fumes from indoor use of biomass fuel (such as wood, straw, and dung) pose much greater health risks than any outdoor pollution. Women and children suffer most from this form of pollution, and its effects on health are often equivalent to those of smoking several packs of cigarettes a day.

OTHER FORMS OF POLLUTION. An estimated 1 billion people live in cities that exceed WHO standards for sulfur dioxide. Nitrogen oxides and volatile organic compounds are a problem in a smaller but growing number of rapidly industrializing and heavily motorized cities.

Soil, water, and agricultural productivity

The loss of productive potential in rural areas is a more widespread and important problem, although less dramatic, than that evoked by images of advancing deserts. Soil degradation, in particular, is the cause of stagnating or declining yields in parts of many countries, especially on fragile lands from which the poorest farmers attempt to wrest a living. Erosion is the most visible symptom of this degradation. Data on soil conditions are of low quality, but crude estimates suggest that in some countries the losses in productive potential attributable to soil depletion may amount to 0.5–1.5 percent of GDP annually. Erosion can also damage economic infrastructure, such as dams, downstream. Even when erosion is insignificant, soils may suffer from nutrient, physical, and biological depletion.

Waterlogging and salinization are serious problems in some irrigated areas and are often the result of policies and infrastructure that inadequately recognize the growing scarcity of water. The increasing conflicts over the use of water mean that in the future, additional growth in agricultural productivity will have to make do with more efficient irrigation and, in some regions, less water overall.

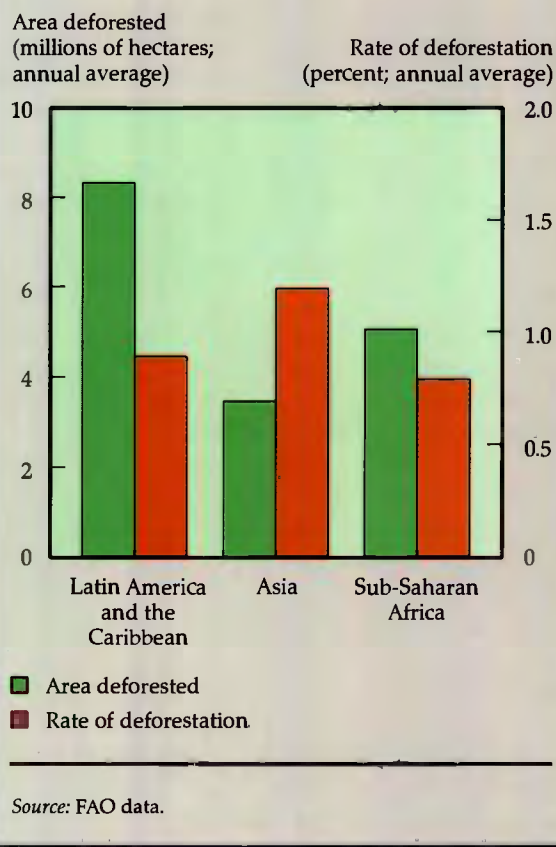
Agricultural intensification will continue as it becomes harder to expand the area of cultivation. High levels of inputs and changes in land use will cause problems for farm communities and other parts of the economy. These problems, once confined mainly to the highly intensive agricultural systems of Europe and North America, are now increasing in such areas as the Punjab, Java, and parts of China.

Natural habitats and loss of biodiversity

Forests (especially moist tropical forests), coastal and inland wetlands, coral reefs, and other ecosystems are being converted or degraded at rates that are high by historical standards. Tropical forests have declined by one-fifth in this century, and the rate has accelerated. As Figure 2 shows, in the 1980s tropical deforestation occurred at a rate of 0.9 percent a year, with Asia's rate slightly higher

Tropical forests declined at an unprecedented rate in the 1980s

Figure 2 Loss of tropical forests in developing regions, 1980-90



(1.2 percent) and Sub-Saharan Africa's lower (0.8 percent). The loss of forests has severe ecological and economic costs—lost watershed protection, local climate change, lost coastal protection and fishing grounds—and affects people's lives. African women have to walk farther for fuelwood, indigenous forest dwellers in the Amazon have succumbed to settlers' diseases, and 5,000 villagers in the Philippines were recently killed by flooding caused in part by the deforestation of hillsides.

Extinction of species is occurring at rates that are high by historical standards, and many more species are threatened because their habitats are being lost. Models that link species extinction to habitat loss suggest that rapid rises in the rate of extinction to levels approaching those of prehistoric mass extinctions may be difficult to avoid in the next century unless current rates of deforestation and other habitat loss are sharply reduced.

Greenhouse warming

The buildup of carbon dioxide and other greenhouse gases will raise average temperatures on earth. The size of the effect remains unclear, but the best estimate of the International Panel on Climate Change (IPCC) is that average world temperatures may rise by 3° Celsius by the end of the next century under their "business as usual" scenario, with a range of uncertainty of from less than 2° Celsius to more than 5° Celsius. There is even more uncertainty about the consequences than about the extent of global warming. Although recent research has reduced fears that icecaps might melt or that the sea level might rise precipitously, there are still grounds for concern. Low-lying nations are at risk, and forests and ecosystems may not adapt easily to shifts in climatic zones. The consequences will depend both on whether policies are adopted to reduce emissions and on how effective economies are in adapting to rising temperatures. The best estimates, still extremely crude and largely based on studies in industrial countries, are that the economic costs are likely to be modest in comparison with the welfare gains brought about by higher incomes. But these costs will not be evenly distributed: climate changes will not be uniform, countries will differ in their capacity to respond to change, and the importance of agriculture, the most climate-sensitive part of the economy, differs among countries. Research is beginning on a modest scale into the potential effects on tropical agriculture; more needs to be done.

Development, the environment, and the long-term prospect

The environmental problems that countries face vary with their stage of development, the structure of their economies, and their environmental policies. Some problems are associated with the *lack* of economic development; inadequate sanitation and clean water, indoor air pollution from biomass burning, and many types of land degradation in developing countries have poverty as their root cause. Here the challenge is to accelerate equitable income growth and promote access to the necessary resources and technologies. But many other problems are exacerbated by the *growth* of economic activity. Industrial and energy-related pollution (local and global), deforestation caused by commercial logging, and overuse of water are the result of economic expansion that fails to take account of the value of the environment. Here the challenge is to build the recognition of environ-

mental scarcity into decisionmaking (Box 2). With or without development, rapid population growth may make it more difficult to address many environmental problems.

The importance of population and poverty programs

The world's population is now growing by about 1.7 percent a year. Although the rate is down from its peak of 2.1 percent in the late 1960s, absolute growth—almost 100 million a year—has never been higher. During the period 1990–2030 the world's population is likely to grow by 3.7 billion—an increase much greater than in any previous generation and probably much greater than in any succeeding one. Ninety percent of this increase will occur in developing countries. Over the next four decades Sub-Saharan Africa's population is expected to rise from 500 million to 1.5 billion, Asia's from 3.1 billion to 5.1 billion, and Latin America's from 450 million to 750 million.

Rapid population growth often contributes to environmental damage. Traditional land and resource management systems may be unable to adapt fast enough to prevent overuse, and governments may be unable to keep up with the infrastructural and human needs of a growing population. In addition, the sheer density of population will pose challenges for environmental management. Today, for example, apart from small islands and city states, only Bangladesh, the Republic of Korea, the Netherlands, and the island of Java, Indonesia, have densities exceeding 400 per square kilometer. By the middle of the next century, however, one-third of the world's population will probably live in countries with these population densities. Virtually all South Asia would have such densities (Bangladesh's would rise to 1,700 per square kilometer), as would a substantial number of African countries, the Philippines, and Viet Nam.

Rapid population growth can exacerbate the mutually reinforcing effects of poverty and environmental damage. The poor are both victims and agents of environmental damage. Because they lack resources and technology, land-hungry farmers resort to cultivating erosion-prone hill-sides and moving into tropical forest areas where crop yields on cleared fields usually drop sharply after just a few years. Poor families often have to meet urgent short-term needs, prompting them to "mine" natural capital through, for example, excessive cutting of trees for firewood and failure to replace soil nutrients.

Agricultural stagnation in Sub-Saharan Africa is

Box 2 Sustainable development

The term "sustainable development" was brought into common use by the World Commission on Environment and Development (the Brundtland Commission) in its seminal 1987 report *Our Common Future*. The idea of sustaining the earth has proved a powerful metaphor in raising public awareness and focusing on the need for better environmental stewardship.

The Brundtland Commission's definition of the term—"meeting the needs of the present generation without compromising the needs of future generations"—is strongly endorsed by this Report. We also believe, with the Brundtland Commission, that meeting the needs of the poor in this generation is an essential aspect of sustainably meeting the needs of subsequent generations. There is no difference between the goals of development policy and appropriate environmental protection. Both must be designed to improve welfare.

Making the concept of sustainability precise, however, has proved difficult. It is not plausible to argue that all natural resources should be preserved. Successful development will inevitably involve some amount of land clearing, oil drilling, river damming, and swamp draining. Some have argued that natural capital should be preserved in some aggregate sense, with losses in one area replenished elsewhere. This approach has helpfully focused attention on the need to estimate the value of environmental resources and on the importance of protecting certain essential ecological systems.

This Report supports efforts to assess values but goes further. Societies may choose to accumulate human capital (through education and technological advance) or man-made physical capital in exchange, for

example, for running down their mineral reserves or converting one form of land use to another. What matters is that the overall productivity of the accumulated capital—including its impact on human health and aesthetic pleasure, as well as on incomes—more than compensates for any loss from depletion of natural capital. In the past the benefits from human activity have often been exaggerated, and the costs of environmental loss have been ignored. These costs must be built into decisionmaking, and all short- and long-term impacts must be carefully explored. This cannot be done without taking account of the uncertainties and irreversibilities associated with some environmental processes, recognizing that some environmental benefits come in intangible forms and that some impacts occur far into the future. Not all environmental resources can or should be assigned monetary values, but tradeoffs should be made as explicit as possible.

It is sometimes argued that the benefits from human investment are temporary, while the benefits of an undisturbed environment last forever. This has prompted some to advocate using a lower discount rate in project analysis. But this may lead to *more* damage (through encouraging investment) rather than less. The answer lies not in artificially lowered discount rates but in ensuring that the benefits from an expanding economy are reinvested.

Basing developmental and environmental policies on a comparison of benefits and costs and on careful macroeconomic analysis will strengthen environmental protection and lead to rising and sustainable levels of welfare. When this Report uses "sustainable development" and "environmentally responsible development," it refers to this narrower definition.

a particularly clear example of the mutually reinforcing nexus of poverty, population growth, and environmental damage. The slowly evolving intensification that occurred in the first half of this century was disrupted by the sharp acceleration of population growth in the past four decades. Low agricultural productivity, caused mainly by poor incentives and poor provision of services, has delayed the demographic transition and encouraged land degradation and deforestation, which in turn lowered productivity. Africa's forest declined by 8 percent in the 1980s; 80 percent of Africa's pasture and range areas show signs of damage; and in such countries as Burundi, Kenya, Lesotho, Liberia, Mauritania, and Rwanda fallow periods are often insufficient to restore soil fertility.

Ninety percent of the increase in the world's population will occur in urban areas. Indeed, only

in Sub-Saharan Africa, the Middle East and North Africa, and Central America are rural populations expected to be still increasing through the next generation. Urbanization will help reduce pressure on the rural environment, but it brings with it a different set of challenges associated with industrial growth, emissions, and wastes.

The only lasting solution to the diverse problems caused by rapid population growth lies in policies that will improve human skills, increase productivity, and so raise incomes. Improving education for girls may be the most important long-term environmental policy in Africa and in other parts of the developing world. Education is a powerful cause of reduced fertility; a recent cross-country study found that, on average, a secondary education reduces from seven to three the number of children a woman has. Access to family plan-

ning services also must be increased. The rate of contraceptive use in developing countries rose from 40 percent in 1980 to 49 percent in 1990. The population projections given above assume that the rate will rise to 56 percent by 2000 and to 61 percent by 2010. This will require expenditures on family planning programs to rise from \$5 billion to \$8 billion during the 1990s.

Economic growth and the environment

What pressures will economic growth place on the natural environment in the coming years? To assess this question, the Report explores a long-term projection of economic output. Under present productivity trends, and given projected population increases, developing country output would rise by 4–5 percent a year between 1990 and 2030 and by the end of the period would be about five times what it is today. Industrial country output would rise more slowly but would still triple over the period. World output by 2030 would be 3.5 times what it is today, or roughly \$69 trillion (in 1990 prices).

If environmental pollution and degradation were to rise in step with such a rise in output, the result would be appalling environmental pollution and damage. Tens of millions more people would become sick or die each year from environmental causes. Water shortages would be intolerable, and tropical forests and other natural habitats would decline to a fraction of their current size. Fortunately, such an outcome need not occur, nor will it if sound policies and strong institutional arrangements are put in place.

The earth's "sources" are limited, and so is the absorptive capacity of its "sinks." Whether these limitations will place bounds on the growth of human activity will depend on the scope for substitution, technical progress, and structural change. Forcing decisionmakers to respect the scarcity and limits of natural resources has a powerful effect on their actions. For example, whereas fears that the world would run out of metals and other minerals were fashionable even fifteen years ago, the potential supply of these resources is now outstripping demand. Prices of minerals have shown a fairly consistent downward trend over the past hundred years. They fell sharply in the 1980s, leading to gluts that threatened to impoverish countries dependent on commodity exports.

With some other natural resources, by contrast, demand often exceeds supply. This is true of the demand for water, not only in the arid areas of the Middle East but also in northern China, east Java, and parts of India (see Figure 3). Aquifers are be-

Water is critically scarce in some areas but plentiful overall

Figure 3 Water use and scarcity, by region



Note: Regional groups include high-income economies. Data are from the 1970s and 1980s.

a. Includes South Africa.

b. No countries have annual per capita water resources of less than 2,000 cubic meters.

Sources: Environmental data appendix table A.3; World Bank data.

ing depleted, sometimes irreversibly, and the extraction from rivers is often so great that their ecological functions are impaired and further expansion of irrigation is becoming severely limited.

The reason some resources—water, forests, and clean air—are under siege while others—metals, minerals, and energy—are not is that the scarcity of the latter is reflected in market prices and so the forces of substitution, technical progress, and structural change are strong. The first group is

characterized by open access, meaning that there are no incentives to use them sparingly. Policies and institutions are therefore necessary to force decisionmakers—corporations, farmers, households, and governments—to take account of the social value of these resources in their actions. This is not easy. The evidence suggests, however, that when environmental policies are publicly supported and firmly enforced, the positive forces of substitution, technical progress, and structural change can be just as powerful as for marketed inputs such as metals and minerals. This explains why the environmental debate has rightly shifted away from concern about *physical limits* to growth toward concern about incentives for *human behavior* and policies that can overcome *market and policy failures*.

Figure 4 illustrates how rising economic activity can cause environmental problems but can also, with the right policies and institutions, help address them. Three patterns emerge:

- Some problems decline as income increases. This is because increasing income provides the resources for public services such as sanitation and rural electricity. When individuals no longer have to worry about day-to-day survival, they can devote resources to profitable investments in conservation. These positive synergies between economic growth and environmental quality must not be underestimated.

- Some problems initially worsen but then improve as incomes rise. Most forms of air and water pollution fit into this category, as do some types of deforestation and encroachment on natural habitats. There is nothing automatic about this improvement; it occurs only when countries deliberately introduce policies to ensure that additional resources are devoted to dealing with environmental problems.

- Some indicators of environmental stress worsen as incomes increase. Emissions of carbon and of nitrogen oxides and municipal wastes are current examples. In these cases abatement is relatively expensive and the costs associated with the emissions and wastes are not yet perceived as high—often because they are borne by someone else. The key is, once again, policy. In most countries individuals and firms have few incentives to cut back on wastes and emissions, and until such incentives are put into place—through regulation, charges, or other means—damage will continue to increase. The experience with the turnarounds achieved in other forms of pollution, however, shows what may be possible once a policy commitment is made.

Figure 4 does not imply an inevitable relationship between income levels and particular environmental problems; countries can choose policies that result in much better (or worse) environmental conditions than those in other countries at similar income levels. Nor does it imply a static picture; as a result of technological progress, some of these curves have shifted downward over recent decades, providing an opportunity for countries to develop in a less damaging manner than was possible earlier.

Policies for development and the environment

Two broad sets of policies are needed to attack the underlying causes of environmental damage. Both are necessary. Neither will be sufficient on its own.

- Policies that seek to harness the positive links between development and the environment by correcting or preventing policy failures, improving access to resources and technology, and promoting equitable income growth

- Policies targeted at specific environmental problems: regulations and incentives that are required to force the recognition of environmental values in decisionmaking.

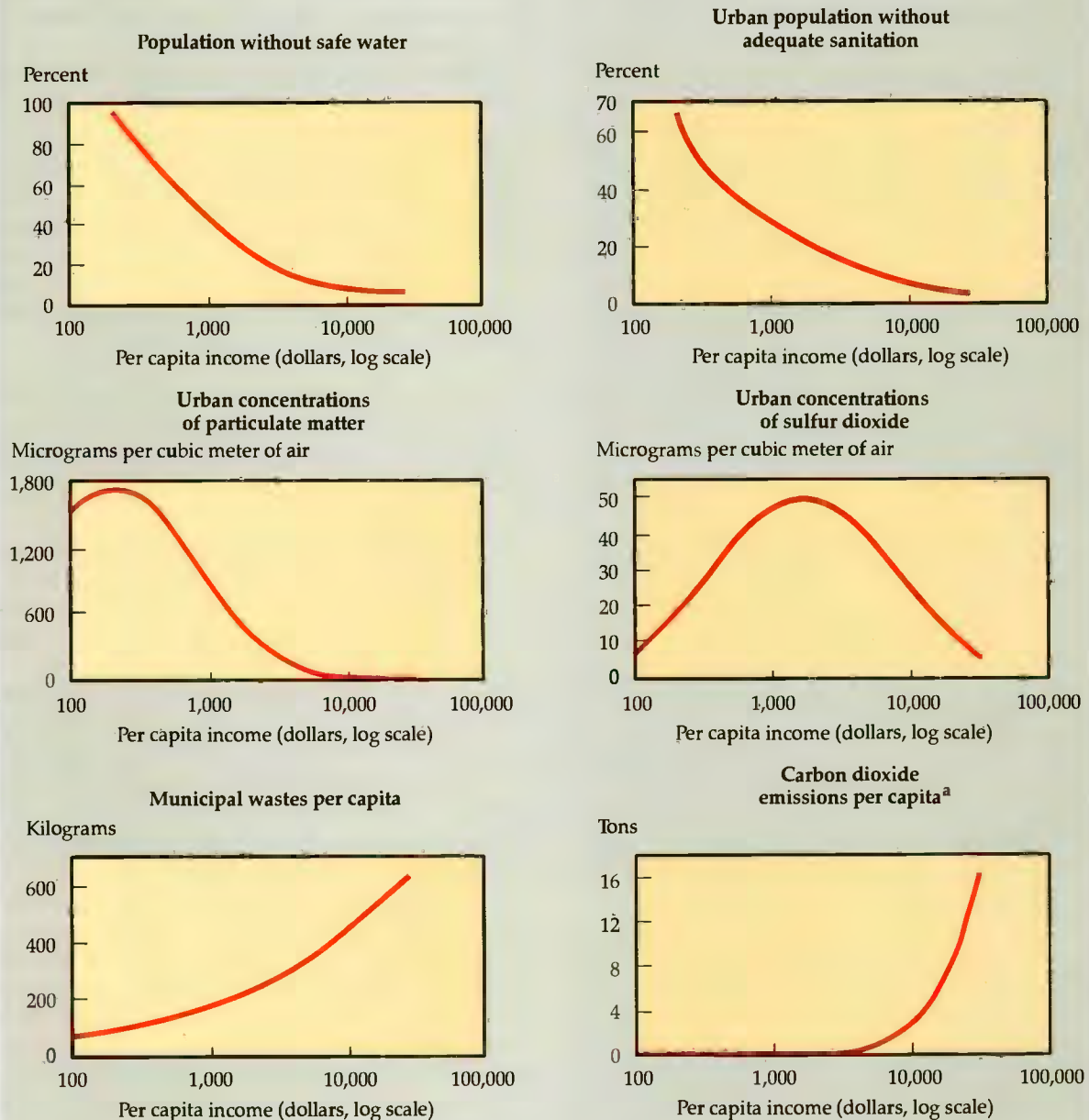
Building on the positive links

Fortunately, many policies that are good for efficiency are also good for the environment. Policies that encourage efficiency lead to less waste, less consumption of raw materials, and more technological innovation.

World Development Report 1991 described a set of “market-friendly” policies for development. These included investing in people through education, health, nutrition, and family planning; creating the right climate for enterprise by ensuring competitive markets, removing market rigidities, clarifying legal structures, and providing infrastructure; fostering integration with the global economy through promotion of open trade and capital flows; and ensuring macroeconomic stability.

All these policies can *enable* better environmental management. For example, improved education is essential for the widespread adoption of environmentally sound agricultural technologies, which are more knowledge-intensive than conventional approaches. And freedom of international capital flows can facilitate the transfer of new and cleaner technologies. Two elements of this package are especially important: the removal of distortions that encourage too much resource use, and the clarification of property rights.

Figure 4 Environmental indicators at different country income levels



Note: Estimates are based on cross-country regression analysis of data from the 1980s.

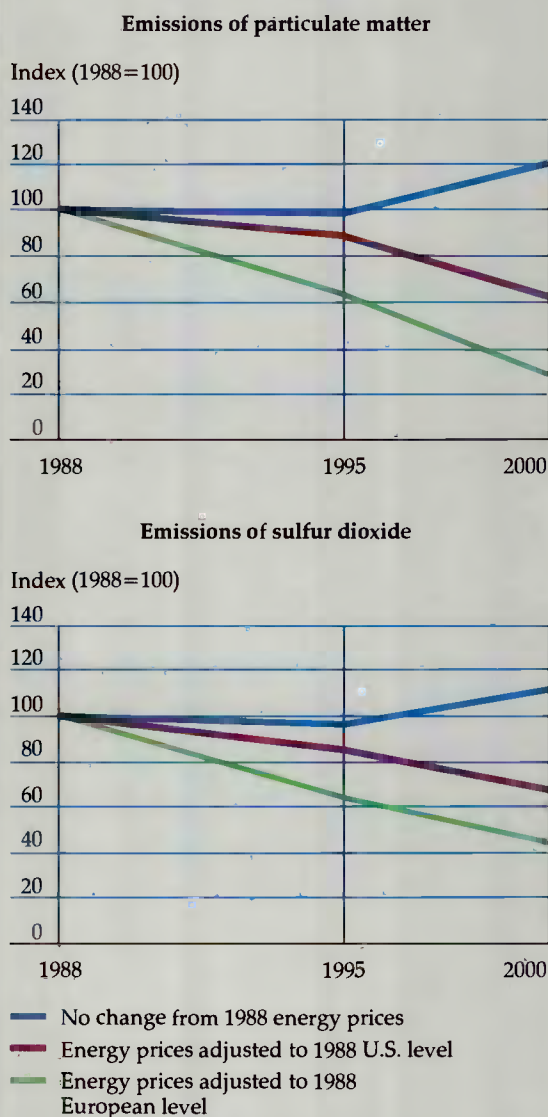
a. Emissions are from fossil fuels.

Sources: Shafik and Bandyopadhyay, background paper; World Bank data.

REMOVING DISTORTIONS. Some government policies are downright harmful to the environment. Notable here are distorted prices in general and subsidized input prices in particular. Subsidies for energy, for example, cost developing country gov-

ernments more than \$230 billion a year—more than four times the total world volume of official development assistance. The former U.S.S.R. and Eastern Europe account for the bulk of this amount (\$180 billion); estimates suggest that more than

Figure 5 Effect of energy prices on air pollution in Poland, 1988-2000



Source: World Bank estimates.

half of their air pollution is attributable to these distortions (see Figure 5). The removal of all energy subsidies—including those on coal in industrial countries—would not only produce large gains in efficiency and in fiscal balances but would sharply reduce local pollution and cut worldwide carbon emissions from energy use by 10 percent. Other distortionary incentives have also had serious environmental consequences. Logging fees

in a sample of five African countries ranged from 1 to 33 percent of the costs of replanting. Irrigation charges in most Asian countries covered less than 20 percent of the costs of supplying the water. And pesticide subsidies in a sample of seven countries in Latin America, Africa, and Asia ranged from 19 to 83 percent of costs.

Distorted incentives are often particularly evident in the behavior of state-owned enterprises. This is important because many sectors in which state enterprises are prominent—power generation, cement, steel, and mining—are heavy polluters; the “commanding heights” are also the “polluting heights.” Thus, the environment can benefit if the managers of state enterprises are made more accountable and are exposed to the same competition as is the private sector.

CLARIFYING PROPERTY RIGHTS. When people have open access to forests, pastureland, or fishing grounds, they tend to overuse them. Providing land titles to farmers in Thailand has helped to reduce damage to forests. The assignment of property titles to slum dwellers in Bandung, Indonesia, has tripled household investment in sanitation facilities. Providing security of tenure to hill farmers in Kenya has reduced soil erosion. Formalizing community rights to land in Burkina Faso is sharply improving land management. And allocating transferable rights to fishery resources has checked the tendency to overfish in New Zealand.

The most serious mistake that governments make in seeking to eliminate open access is to nationalize resources in the name of conservation. Nationalization has often reflected the failure of policymakers and aid agencies to distinguish between traditional common-property systems, which promote sound management of natural resources, and open-access systems that result in excessive exploitation. When land and water have been nationalized and traditional management arrangements abandoned, the environmental consequences have often been severe, as they were in the forests of Nepal.

Targeted policies to change behavior

The policies described above are important, but they are not enough. Eliminating fuel subsidies will not be sufficient to end air pollution in Beijing or Mexico City. And it simply is not practical to find property-rights solutions for most of those environmental problems that adversely affect a large number of people “offsite”—air and water pollution, watershed destruction, loss of biodiversity,

and the like. For these situations specific policies are required to induce or require resource users to take account of the spillover effects that their actions have on the rest of society.

Policies designed to change behavior are of two broad types: those based on incentives ("market-based" policies), which tax or charge polluters according to the amount of damage they do, and those based on quantitative restrictions ("command-and-control" policies), which provide no such flexibility.

Market-based instruments are best in principle and often in practice. They encourage those polluters with the lowest costs of control to take the most remedial action, and they thus impose less of a burden on the economy. A survey of six studies of air pollution control in the United States found that least-cost policies could reduce the costs of control by 45–95 percent in comparison with the actual policies implemented. Economic incentives have been used for years in indirect, or blunt, forms such as fuel and vehicle taxes (most OECD countries), congestion charges (Singapore), and surcharges on potentially damaging inputs such as pesticides and plastics (Denmark and Sweden). More specific charges, such as the newly introduced carbon taxes in some European countries, tradable permits for air pollution (in the United States), deposit-refund schemes for bottles and batteries (in several European countries), hazardous waste charges and performance bonds, which are under consideration in Bangkok, and surcharges on stumpage fees to pay for replanting, as in Indonesia, are growing in importance. Industrial countries have been slow to adopt market-based strategies, in part because environmentalists contended that degrading the environment was unacceptable at any price, but more importantly because corporations feared that they would have to adopt emissions standards *and also* pay charges on the remaining emissions. Most now agree that market-based instruments have been underutilized. They are particularly promising for developing countries, which cannot afford to incur the unnecessary extra costs of less-flexible instruments that have been borne by OECD countries.

Quantitative command-and-control instruments, such as specific regulations on what abatement technologies must be used in specific industries, have acquired a bad name in recent years for their high costs and for stifling innovation. But in some situations they may be the best instruments available. Where there are a few large polluters, as was the case in the industrial city of Cubatão in Brazil, direct regulation may be the quickest and

most effective instrument. Management of land use in frontier areas is another example of situations that may require direct controls.

The appropriate choice among instruments will depend on circumstances. Conserving scarce administrative capacity is an important consideration. For many developing countries blunt instruments that avoid the need for detailed monitoring will be attractive. These may involve taxes or charges on polluting inputs rather than on the pollution itself. Also attractive will be policies that provide self-enforcing incentives, such as deposit-refund and performance-bond schemes.

Several lessons can be drawn from recent experience:

- *Standards should be realistic and enforceable.* Many developing countries have set unrealistically tight standards—often those of OECD countries—and have enforced them only selectively. This has wasted resources, facilitated corruption, and undermined the credibility of all environmental policies. Laws on the books and zoning charts on the walls of government offices are often a genuine indication of concern, but unless policies are implemented, they can give a false sense that serious problems are under control. Better to have fewer and more realistic standards that are truly implemented.

- *Controls must be consistent with the overall policy framework.* Many well-intentioned policies have been thwarted by other policies that pull in the opposite direction. Both China and Poland have had pollution taxes for years, but to no effect; state-owned enterprises were not interested in profitability. Land-use planning in Sub-Saharan Africa has usually failed in the face of policies that did not encourage intensification and off-farm employment. Brazil's concern about overfishing off the Bahia coast was undermined in the early 1980s by government subsidies for new nylon nets.

- *A combination of policies will often be required.* Because environmental damage is frequently caused by different actors and for different reasons, a single policy change may not be enough. Reducing air pollution from vehicles in Mexico City, for example, will require mandated emissions and engine standards, fuel improvements, and gasoline taxes.

Reviewing public expenditures

Public expenditures can have a remarkable effect on the environment—for bad or for good. It is now clear that numerous public investments—often supported by development agencies, including

the World Bank—have caused damage by failing to take environmental considerations into account or to judge the magnitude of the impacts. Indonesia's transmigration program, Sri Lanka's Mahaweli scheme, and Brazil's Polonoreste projects are examples of large programs that caused unanticipated damage in earlier years. But equally important are design issues relating to individual project components—road alignments, the design of water systems, and the provision of access to forests and wetlands.

Beginning with analysis in the 1950s and 1960s of hydroelectric projects in the United States, considerable progress has been made in applying cost-benefit techniques to environmental concerns. Such analyses have tripled estimated returns for some forestry projects and halved returns on some hydroelectric and road projects, making the latter unattractive.

Most countries and aid agencies have recently introduced environmental assessment procedures. These are still early days for such arrangements; technical skills need to be developed, and lessons are being learned about the difficulties of incorporating assessment results, which are often non-quantitative, into decisionmaking. Making the process transparent has been found to be an important way of improving its quality and impact. Listening to local views has also proved essential; some lessons from World Bank experience are that information must be shared with local people early in the life of the project and that comments from affected communities must be incorporated into project design.

Removing impediments to action

Even when straightforward ways of tackling environmental problems exist, governments have often found it difficult to translate them into effective policy. The reasons for the gap between intentions and performance include political pressures, an absence of data and knowledge, weak institutions, and inadequate participation of local people in finding solutions.

Counteracting political pressures

Stopping environmental damage often involves taking rights away from people who may be politically powerful. Industrialists, farmers, loggers, and fishermen fiercely defend their rights to pollute or to exploit resources. Examples of the results include modification of proposed carbon taxes in Europe to assist energy-intensive industries, delay in the introduction of transferable fishing rights in Chile because of pressure from powerful fishing

interests, and lack of progress almost everywhere in introducing irrigation charges. Those who are hurt when the environment is degraded, and who stand to gain most from sound policies, are often the poor and the weak. They may be less potent politically than the polluters whom governments must challenge.

A second reason for disappointing performance has to do with the inability of governments to regulate themselves. The problem arises partly because state bodies have conflicting social and economic objectives, which allow them to use resources less efficiently, and partly because of the inherent contradictions of being both gamekeeper and poacher. In the United States, for example, publicly owned municipal wastewater treatment plants are the most persistent violators of effluent discharge standards.

While private and public polluters may obstruct policy, other influences may persuade governments to set the wrong priorities. International pressures may favor issues of interest to donors rather than to developing countries. And there is always a tendency to focus on dramatic problems rather than chronic ones; few pressure groups, for example, lobby for improved sanitation or for reduced indoor air pollution. Moreover, governments may be pressed to address problems such as air pollution that affect everybody, including the rich, rather than problems such as fecal coliforms in rivers from which the rich can insulate themselves.

Improving information

Ignorance is a serious impediment to finding solutions. Governments often make decisions in the absence of even rudimentary information. International initiatives are urgently needed to overcome a grave lack of knowledge in some areas, including soil depletion (especially in Africa), land productivity in and around tropical forests, and global atmospheric issues. Countries can reap large returns from investments in basic environmental data on exposure to emissions and unsanitary conditions, soil and water depletion, land capability, and loss of forests and natural habitat.

Understanding the causes and effects of environmental damage and the costs and benefits of action is the next stage. Following a careful analysis, authorities in Bangkok found that attacking lead and particulate emissions deserved the highest priority. The U.S. Environmental Protection Agency estimated that, as a measure for avoiding deaths, placing controls on unvented indoor heaters was 1,000 times more cost-effective than

further tightening certain hazardous wastes standards. A study in southern Poland discovered that the benefits from reducing emissions of particulates would greatly exceed costs but that this would not be true of controls on sulfur dioxide.

Independent commissions have proved a useful way for governments to draw on technical expertise; a growing number of developing countries, including Hungary, Nigeria, and Thailand, are finding that ad hoc commissions can bring professional objectivity to highly charged issues. In Africa, national environmental action plans, which have already been completed for Lesotho, Madagascar, and Mauritius and are under preparation for seventeen other countries, are bringing technical experts and citizens' groups into the process of setting priorities and policies.

Enhancing institutional arrangements

Governments around the world are actively seeking to strengthen their institutional capacity for environmental management. In addition to the clear needs for better technical skills, adequate finance, and a clarification of environmental regulations, experience suggests four priorities.

- *Clarify objectives and ensure accountability.* The public agencies that implement programs for the environment—forest and land departments, irrigation and water supply authorities, public works departments, and agricultural extension services—need to be held accountable for the environmental impact of their activities. The same applies to donors and aid agencies.

- *Establish the capacity to set priorities and monitor progress.* No ideal blueprint exists for environmental institutions, but a formal high-level agency for setting policies and ensuring implementation across sectors has sharply improved environmental management in Brazil, China, and Nigeria.

- *Ensure areawide coordination.* Where intersectoral decisions need to be made—the management of water within a river basin, the citywide management of pollution and wastes, the protection of a large populated forest area—coordination is required to ensure consistency and cost-effectiveness. Areawide organizations responsible for *implementation* of intersectoral plans have generally failed. Mechanisms for *coordination*, however, are essential: the recently established regional pollution units in Santiago and Mexico City are promising examples.

- *Regulate at arm's length.* Implementing agencies should be held accountable for the effects of their actions and should be kept separate from regulatory and monitoring bodies.

Involving local people

Making choices between economic and social benefits and environmental costs often requires subjective judgments and detailed local knowledge. Neither governments nor aid agencies are equipped to make judgments about how local people value their environment. A participatory process is essential. Local participation also yields high economic and environmental returns in implementing programs of afforestation, soil management, park protection, water management, and sanitation, drainage, and flood control.

Development projects that have not built on the strengths of existing practices have often failed. Haiti's top-down reforestation program was unsuccessful until small farmers and community groups were allowed to choose what kinds of trees should be planted, and where. Then, instead of the target of 3 million trees on 6,000 family farms, 20 million trees were planted on 75,000 farms. A large irrigation project in Bali, Indonesia, that failed to recognize the advantages of traditional approaches to pest management had disastrous results. A follow-up project that built on indigenous strengths succeeded.

Involving people can be expensive and in some instances can paralyze decisionmaking, hold public investments hostage to unproductive NIMBY ("not-in-my-backyard") activism, and reinforce local power structures. Experience suggests that success is greatest when tasks are devolved selectively and on the basis of actual performance. Increasing responsibilities for local governments is an important part of this process. Public agencies need training in participatory approaches and a clear indication from senior management of the importance of participation.

Putting policies to work

How can these principles be applied in practice? This Report organizes the discussion around four themes: water and sanitation, emissions from energy and industry, rural environmental challenges, and environmental challenges that cross national borders.

Water and sanitation

Investments in providing clean water and sanitation have some of the highest economic, social, and environmental returns anywhere. The 1980s witnessed progress in coverage, but the costs of inadequate provision remain enormous. In India no water supply system reliably provides water twenty-four hours a day. In rural Pakistan only 10

percent of public handpumps were functioning ten years after their installation. In the first ten weeks of the recent cholera epidemic in Peru, losses in agricultural exports and revenues from tourism were more than three times the amount that the country had invested in sanitation and water supply in the 1980s. There is growing recognition that current approaches will not meet the needs of the coming years. Changes are needed in four areas:

IMPROVING MANAGEMENT OF WATER RESOURCES. Domestic water use in developing countries will need to rise sixfold over the coming four decades. The bulk of demand will come from urban areas, where populations will triple. This increase will place severe strains on surface and groundwater supplies and will call for much more efficient allocation within river basins.

Irrigation accounts for more than 90 percent of withdrawals in low-income countries and for 70 percent in middle-income countries but for only 39 percent in high-income countries. Since domestic use almost always has a much higher private and social value than does irrigation, it is from the latter that water will need to be redirected. Governments around the world are grappling, often unsuccessfully, with the complex legal and cultural obstacles to reallocating water. Taking rights from rural areas may be impossible for legal or political reasons or undesirable for equity reasons. One solution is for urban areas to compensate farmers for the loss of irrigation water. This need not be prohibitively expensive; the current inefficiencies in use of irrigation water are so great that substantial reductions in use are often possible with only modest reductions in agricultural output.

Urban water must also be used more efficiently. Unaccounted-for water, much of it unused, constitutes 58 percent of piped water supply in Manila and about 40 percent in most Latin American countries. The reclamation of wastewater is helping conserve water in a growing number of cities, including Mexico City and Singapore, and will continue to expand.

RESPONDING TO CUSTOMER DEMANDS. The most effective means of encouraging the efficient use of water is to raise and enforce charges. On average, households in developing countries pay only 35 percent of the cost of supplying water. The vast majority of urban residents want in-house supplies of water and are willing to pay the full cost. Most countries, however, have assumed that people cannot afford to pay the full costs, and they

have therefore used limited public funds to provide a poor service to restricted numbers of people. A vicious cycle of low-level and low-reliability service and correspondingly low willingness to pay ensues. The poor suffer the most from the very policies that were supposed to help them. Excluded from the formal system, they typically pay water vendors ten times as much for a liter of water as the full cost of the same amount of piped water. But it is possible to break this pattern. First, provide those willing to pay with a good commercial service. Second, explore ways of bringing services to those unable to pay (who are much less numerous than was once thought)—by allowing longer payoff periods for capital costs, setting carefully targeted “social tariffs,” or both. Third, offer people with different incomes a broader menu of options.

INCREASING INVESTMENTS IN SANITATION. Aggregate investments in water and sanitation were inadequate in the 1980s (public investment accounted for about 0.5 percent of GDP), but investments in sanitation were especially low. Most investments have been for sewage collection, with almost nothing for treatment. For example, today only 2 percent of sewage in Latin America is treated. Evidence is accumulating in countries such as Brazil, Burkina Faso, Ghana, and Pakistan that willingness to pay for household sanitation at all income levels is much higher than had been thought and is roughly equivalent to what people will pay for water and for electricity. This suggests a variety of ways of financing services if facilities can be tailored to incomes. That task may be helped by important innovations now occurring in sanitation.

RETHINKING INSTITUTIONAL ARRANGEMENTS. A recent review of forty years of World Bank experience in the water and sanitation sector identified institutional failure as the most frequent and persistent cause of poor performance. The number of employees per 1,000 water connections is two to three in Western Europe but ten to twenty in Latin America. Even so, in cities such as Caracas and Mexico City 30 percent of connections are not registered. Two conditions for better performance are essential: utilities need to be made more autonomous and more accountable for their performance, and they need to be placed on a sounder financial footing through better pricing policies. The private sector must also play a greater role. Côte d’Ivoire was a pioneer in privatizing water supply; the

Abidjan utility is one of the best run in Africa. When Guinea began franchising water supply, collection rates rose from 15 to 70 percent in eighteen months. Santiago, which contracts out many components of its water services to the private sector, has the highest staff productivity in the sector in Latin America. What holds for water supply is even more relevant to the management of solid wastes.

Privatization is not a panacea. Regulation issues are complex, and in some countries no private firms bid on contracts. Nonetheless, it is certain that the trend toward privatization will accelerate in the 1990s.

Emissions from energy and industry

The costs of pollution from industry, energy, and transport are already high and will grow exponentially if these problems are neglected. Encouraging energy conservation is a helpful first step in tackling pollution. But it cannot solve the problem alone. The effects of rising populations and incomes will soon swamp any reductions in demand per person. It is thus absolutely essential to reduce emissions per unit of production. This requires investment in new equipment and the development of new technologies.

REDUCING HOUSEHOLD ENERGY POLLUTION. Household energy use creates both indoor and outdoor air pollution. Indoor pollution is very serious in Africa and South Asia, where biomass is burned for cooking in unventilated rooms. Outdoor pollution is a great problem where low-quality coal is burned, as in China, India, and Eastern Europe.

Progress in dealing with indoor air pollution has been disappointing. Higher incomes and improved distribution systems for commercial fuels and electricity will bring about a switch away from biomass, which now accounts for 35 percent of energy use in developing countries. In the meantime, improved biomass stoves, which increase efficiency and reduce emissions, can make an important contribution and merit greater donor support.

Reduction in outdoor air pollution from household use of coal will turn (as it did in the industrial countries in the 1950s and 1960s) on two developments: policies that favor the adoption of clean coals (such as anthracite) and a transition to oil, gas, electricity, and, sometimes, district heating as household energy sources.

REDUCING POLLUTION FROM GENERATION OF ELECTRIC POWER. Because electric power generation accounts for 30 percent of all fossil fuel consumption

and 50 percent of all coal consumption worldwide, the gains from reduced pollution are substantial. Shifting to natural gas and using clean coal technologies can reduce emissions of particulates and carbon monoxide by 99.9 percent and emissions of sulfur dioxide and nitrogen oxides by more than 90 percent. Curbing emissions of particulates should be the first point of attack. It is cheap—1 to 2 percent of the total capital costs of electric power supply, on average—and, as noted earlier, it is important for human health. All new power plants should have equipment for control of particulate matter. Most new ones do, but the equipment is often not well maintained. The costs of reducing sulfur dioxide and nitrogen oxides are higher (unless natural gas is available), at 5 to 10 percent of capital costs. The effects on health of reducing these emissions are usually much lower than for particulates, and the impacts on forests, agriculture, and buildings vary greatly by area. The case for setting tough standards will depend on circumstances.

Box 3 shows how reducing pollution from electric power production requires both improvements in efficiency and investment in abatement. On average, prices today cover less than half of supply costs in developing countries, and losses in transmission are often three or four times those in industrial countries. Improved management and pricing will conserve resources and facilitate investments in abatement technologies. For example, cutting transmission losses by only one-tenth in Asia would reduce the need for investment in generating capacity during the 1990s by about \$8 billion—almost enough to pay for controls to reduce particulate emissions for every new power plant to be built in the entire developing world during the 1990s.

PROMOTING USE OF RENEWABLE ENERGY. Nonfossil energy sources, especially renewable sources, offer great promise. Solar energy may have the best long-term prospects, especially if strong action is needed on carbon emissions (see below). Each year the earth receives about ten times as much energy from the sun as is stored in all fossil fuel and uranium reserves—the equivalent of 15,000 times the world's primary energy demand. The unit costs of production of photovoltaics and solar-thermal systems have fallen 95 percent in twenty years. The market for photovoltaics grew tenfold in the 1980s and, although still small, is growing at 20 percent a year. Applications include village electrification, irrigation

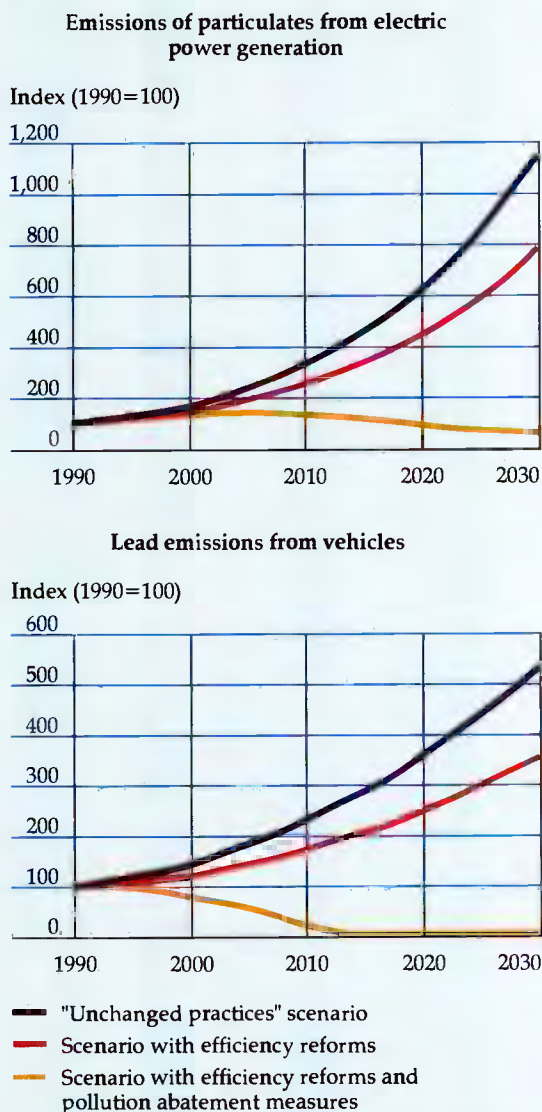
Box 3 Air pollution in developing countries: three scenarios

This Report shows, for a number of environmental problems, three possible paths for future development. The first, the "unchanged practices" scenario, assumes that current policies and patterns of resource use remain the same as in 1990. The second shows what would happen under policy and managerial reforms that would encourage more efficient use of resources. The third shows the effect of introducing both efficiency reforms and cleaner technologies and practices.

These scenarios have been quantified for the cases of pollution from energy and transport, for the use of renewable energy as a long-term means of addressing the problem of global warming, and for sanitation and water supply (see Chapters 5, 6, and 8). As an example, the top panel of Box figure 3 illustrates the case of emissions of particulates from electric power plants. The amount of electric power generated from fossil fuels doubles every five to ten years in developing countries—and so would pollution, in the absence of controls (the top-curve in the figure). Raising electricity prices gradually to cost-reflecting levels (the middle curve) would reduce unnecessary waste in consumption, lower the rate of growth of pollution, and put utilities in a financially better position to invest in cleaner technologies. The bottom curve shows the effect of efficiency reforms plus pollution controls. Controls on particulate matter in coal-fired plants can reduce pollution per unit of output by 99.9 percent over the long term (see Chapter 6 for details). The investment costs for such controls are modest and are dwarfed by the efficiency gains from removing subsidies by a factor of ten to one.

Taxes on vehicle fuels are low in developing countries (and in the United States), and congestion pricing is not much used. The economic reform scenario (middle curve in the bottom panel) illustrates the potential effects on emissions (with no change in fuels) of gradually adjusting taxes to European levels and introducing a "Singapore" model of congestion prices in large cities. This step would have large economic benefits (see Chapters 6 and 8) and would also help to reduce pollution. Even so, emissions from vehicles in developing countries would still quadruple by 2030. The introduction of cleaner fuels and technologies is thus essential, as is illustrated for the case of lead in the bottom panel. Malaysia, Singapore, and now Mexico are phasing in lead-free fuel, using both market incentives (differential fuel and vehicle taxes) and regulations (mandatory catalytic converters and mandated emissions standards). Targeted policies of this kind would have a dramatic effect on pollution abatement (the bottom curve), and the costs would be a small fraction of the economic gains and health benefits.

Box figure 3 Selected air pollutants in developing countries: three scenarios



Source: Anderson and Cavendish, background paper.

pumping, and power for rural health clinics. Less dramatic, but still important, progress has been made in reducing the costs of and utilizing biomass and wind power technologies. Continued rapid reductions in unit costs that can make these energy sources replicable on a very large scale will require help from industrial countries. Currently, only 6 percent of public research funds for energy is allocated to renewable sources (60 percent goes for nuclear energy and 15 percent for fossil fuels). Priorities need to be reordered.

REDUCING POLLUTION FROM TRANSPORT. Vehicles account for one-half of oil consumption in most developing countries and sometimes account for 90 to 95 percent of lead and carbon monoxide emissions. The problems are exacerbated because vehicles are often in poor condition, vehicle use is concentrated (in Mexico and Thailand half the fleet operates in the capital city), and pedestrians spend much more time in the open air than in industrial countries. Lead is the main problem. It is being tackled effectively and relatively cheaply in some countries; concentrations have gone down 85 percent in the United States and 50 percent in Europe over the past two decades. Box 3 describes how lead emissions from vehicles in developing countries could rise fivefold over the coming few decades or could fall to negligible levels. Policy choices account for the difference.

REDUCING INDUSTRIAL POLLUTION. In attacking industrial pollution and wastes, it is necessary to distinguish between large plants, which can be individually monitored and regulated, and the many thousands of small plants, which cannot. The former dominate the heavy, pollution-intensive industries (chemicals, metallurgy, cement, mining, and paper and pulp). The worst problems include emissions of heavy metals from smelters and manufacturing plants (particularly in Eastern Europe) and toxic emissions from chemical and fertilizer plants, especially in Latin America, Asia, and Eastern Europe. Water pollution that takes oxygen from rivers and kills river life is a problem everywhere. Technologies for dealing with these problems already exist and need not be expensive except for the heaviest polluters. Capital spending on controls cost 5 percent of total industrial investment in Germany, Japan, and the United States in the 1980s.

A pragmatic approach to big polluters is required. The common practice of adopting industrial country standards and then negotiating with

individual firms about their enforcement has not worked. It has led to inequities and in some cases, as in Chile's copper-mining industry, is inducing foreign-owned companies to argue for tight standards that are equitably applied. Incentive-based instruments must be more widely used. Effluent charges will be especially important, and some countries, including Thailand, are considering innovative approaches such as the use of performance bonds for the management of hazardous wastes. Revenues from such charges can be used for treatment facilities and to defray the administrative costs associated with environmental audits and enforcement.

Controlling emissions from smaller plants is more difficult and calls for indirect instruments. Taxation of inputs—energy, chemicals, and technologies—can help, and deposit-refund schemes are potentially powerful. Leather tanning and small-scale gold mining pose particular problems because of their toxic emissions into rivers.

Rural environmental challenges

Two important environmental and natural resource challenges face rural people and policymakers:

- Preventing the resource degradation that can result from rapidly growing demands for food, fuel, and fiber and from poor stewardship due to poverty, ignorance, and corruption
- Preserving valuable natural forests, wetlands, coastal areas, and grasslands from being taken over for relatively low-value uses that are artificially encouraged by bad policies, imperfect markets, and flawed institutions.

PROBLEMS ON AND AROUND FARMS. Ninety percent of the doubling in food production over the past quarter century came from higher yields and only 10 percent from cultivating more land. Intensification, which will account for most future increases in production, will create environmental problems. The right policies are of two types: those that enable farmers to do what is in their own interests, such as managing soils better, and those that provide incentives to stop behavior which primarily hurts others.

Protecting soils from erosion and nutrient depletion—an urgent priority in many parts of the world—falls mainly into the first category. Many options are available, including contour-based operations, intercropping, agroforestry, and changes in fertilizer application and animal husbandry.

These improvements can sharply reduce erosion and raise yields and incomes. Why, then, are they not universally undertaken? The reasons include lack of access to credit markets and lack of knowledge of costs and benefits. Sometimes government failures may be the cause; artificially low farmgate prices may undermine profitability, or fertilizers may be rationed because of subsidies or poor distribution channels. In all such cases policies for development and policies for environmental protection are just different aspects of the same agenda. Reforming agricultural policies can be politically difficult. Strengthening local research, extension, and credit systems to enable farmers to make appropriate investments requires a long-term commitment and more support from donors. There is, however, no alternative if agriculture is to be put on a sustainable footing.

The overuse of pesticides is causing two problems: declining effectiveness through the emergence of resistance, and localized health problems caused by runoff. Governments are responding in three ways. First, subsidies on pesticides are being removed and taxes are being imposed. Second, research efforts are yielding pesticides with shorter toxic lives and plants that are less susceptible to pests. Finally, integrated pest management—a technique that uses small, carefully timed applications—is being introduced in numerous countries; it is financially attractive to farmers but requires careful training and follow-up.

COMMUNAL MANAGEMENT OF RESOURCES. Many natural resources in the developing world are managed communally. Often, this results in prudent stewardship. But sometimes management systems collapse as a result of population pressure, technical innovation, or commercialization. Problems include the overgrazing of pastoral rangelands, depletion of village woodlands due to fuelwood collection, deterioration of small-scale irrigation systems, and the overfishing of lakes and near-shore waters.

Where problems are serious, policymakers can seek to strengthen either *communal* rights and management responsibilities or those of *individuals* within the group. Which is appropriate will depend on societal factors and on administrative and legal systems. Strengthening existing institutions should be the first line of action. Experience with pastoral associations in West Africa and elsewhere suggests that successful groups are those characterized by adequate legal protection, clear leadership, and the authority to raise funds. Govern-

ments and nongovernmental groups can help overcome constraints in these areas. Interventions that are too heavy-handed, however, such as the group ranching schemes in Kenya, can erode social cohesion and make individual ownership of property the only option. Nationalization of resources is almost never a good response.

RESOURCES MANAGED BY GOVERNMENTS. In many countries governments own most of the land and natural resources and need to make environmentally responsible decisions on allocating their use.

One demand for land comes from settlers. Much of the 4.5 million hectares brought under cultivation each year are vulnerable lands, and new settlement for agriculture accounts for 60 percent of tropical deforestation. Too often, encroachers deplete resources in a manner that is neither economically nor environmentally viable. Promoting alternative income opportunities, through both off-farm employment and the intensification of agriculture, is the only long-run solution to these pressures—a further argument for adopting sound agricultural policies and human development programs. A study in Thailand found that providing educational opportunities was the single most powerful long-term policy for reducing deforestation.

In an effort to promote the right kind of settlement, some governments have sponsored official settlement programs, with mixed results. A recent World Bank review of its own experience concluded that such programs, which cost an average of \$10,000 per family, were too often driven by targets and plans, tended to select settlers on the wrong criteria, often failed to do adequate soil and hydrologic surveys, and employed inappropriate mechanized land-clearing equipment. Evidence from Colombia and Indonesia indicates that, where property rights are clear, spontaneous settlers can be better resource managers than those who are officially sponsored, because they consider costs and risks. Nonetheless, settlement needs to be guided and serviced. Viable settlement areas need to be identified through better surveys than in the past, titles to land need to be provided to those settlers who demonstrate a capacity for sound resource management, and research and extension on sustainable agricultural techniques is required. Land-use zoning, which has usually failed to achieve its objectives, must be supplemented by the provision of services, by titling, and by penalties for noncompliance. Innovative approaches to integrated land management that allo-

cate land to settlers, loggers, and extractive reserves while ensuring the rights of indigenous people are under way in the Amazon, West Africa, and Malaysia.

Areas that have particularly important ecological or habitat functions need special protection. Traditional reliance on guards and patrols is now being supplemented by integrated conservation and development projects, which build on the principle that local communities must be involved in devising and implementing protection. Nepal and Zimbabwe have pioneered buffer zones around some conservation areas; these zones are intensively managed by local people to generate incomes and establish rules of access that limit future encroachment.

Although logging directly accounts for only 20 percent of deforestation in developing countries, its impact is larger; it establishes access, encouraging farmers and ranchers to follow. Logging practices have been notoriously damaging in the past, and a recent review by the International Tropical Timber Organization found that less than 1 percent of tropical forests subject to logging is sustainably managed. Commercial logging must be limited to areas in which proper management is possible and demonstrated. Priority should be given to the preservation of intact tropical forests and to reforestation of degraded areas. In most places, stumpage fees and concession rents need to be increased to reflect the opportunity costs of cutting down trees. Felling leases or licenses and logging rights can be allocated by competitive bidding that is open to the private sector, local communities, and nongovernmental organizations (NGOs).

International environmental challenges

Institutional mechanisms for dealing with international resource and environmental problems, whether regional or global, are less developed than those available for national decisionmaking. Nonetheless, experience is accumulating from past negotiations, including those on the Law of the Sea, various fishing agreements, international river agreements, conventions on transporting hazardous wastes, and the Montreal Protocol on ozone depletion. Some lessons are that agreements are most effective when they are based on reciprocity and strong national interests; that international agreements often follow catalytic unilateral or regional action; that the lack of capacity to enforce agreements has been an important constraint on their effectiveness; and that financial

and technical assistance may be crucial to a successful outcome.

GREENHOUSE WARMING. Enough is known to discern a threat of climate change from increasing concentrations of greenhouse gases but not enough to predict how much will occur or how fast, the regional distribution of change, or the implications for human societies. A threefold strategy is suggested here.

First, measures should be taken that can be justified mainly by their benefits for efficiency and their effects on local pollution. Removing energy subsidies should be the starting point. Adjusting taxes on energy is the next step. Energy taxation in industrial countries is often skewed in favor of the most carbon-intensive fuels—especially coal. Carbon taxes have been introduced in Finland, the Netherlands, Norway, and Sweden. The nations of the European Community (EC) are considering a proposal for a carbon-cum-energy tax. A number of other measures are also desirable, mainly because of their benefits in other areas. For example, afforestation programs in watersheds and on farms (in the form of agroforestry) often have good returns because of their role in protecting watersheds and soils and, in developing countries, because they are a source of fuelwood. The fact that they sequester carbon makes them even more attractive.

Second, research is urgently needed both on the magnitude of the problem, especially as it may affect developing countries, and on potential solutions. Reducing uncertainty about potential costs and benefits is essential for designing an effective policy response, but it will require a large effort. A high priority should be given to research on energy conservation and renewable energy sources.

Third, pilot programs and innovative approaches to finding lasting solutions in developing countries need to be financed by industrial countries. A coordinated international effort is desirable to minimize duplication of effort and ensure that initiatives are consistent with overall development policies. The Global Environment Facility (GEF) has broken new ground by making finance available for pilot projects to identify the scope for widespread replication and cost reduction of technologies and practices that will lower net greenhouse gas emissions. Its priorities include slowing deforestation and encouraging afforestation; developing renewable sources such as biomass, solar energy, and microhydropower; improving efficiency in end uses; and reducing methane emis-

Box 4 For national policymakers: seven suggestions to guide action

1. *Build the environment into policymaking*

Environmental considerations need to be intrinsic to policymaking, not added on as afterthoughts. Environmental impact statements are already important in project analysis. They need to be extended to policy reforms. Where economic policies bring environmental benefits, those should add support to reform; where they carry possible adverse environmental costs, the adjustment program should include targeted environmental policies to offset them.

2. *Make population a priority*

For the sake of both development and the environment, population issues need more attention. Educating girls, enabling women to earn cash incomes and to participate fully in decisionmaking, and investing in better-equipped and better-financed family planning programs all allow women to determine their own reproductive behavior. It takes time for the environmental effects of these policies to be felt—all the more reason to take action now.

3. *Act first on local damage*

Many people are killed or made ill in developing countries by dirty water, lack of sanitation, fumes from cooking with wood, and dust and lead in city air. Soils impoverished by erosion or poisoned with badly used chemicals make it harder for developing countries to feed their people. Solving these environmental problems brings the biggest gains to health and wealth.

4. *Economize on administrative capacity*

Implementing environmental policy uses scarce money

and manpower. To keep down administrative costs, countries need to set realistic goals and then enforce them; to work where possible with the grain of the market, not against it; to give preference to "self-enforcing" instruments such as deposit-refund schemes; and to harness popular support through local participation.

5. *Assess tradeoffs—and minimize them*

Governments need to be able to assess the costs of environmental damage and the least costly ways of protecting the environment. Policies should be made on the basis of explicit comparisons of cost and benefits. Citizens need to know what is being given up in the name of economic growth and what is being given up in the name of environmental protection.

6. *Research, inform, train*

Research should concentrate on appropriate technologies: low-cost chimneys to vent fumes from burning biomass, cheap sanitation systems to provide service to poor neighborhoods. Good information pays big dividends by helping to set sensible policy priorities. Better skills can solve environmental problems such as inappropriate use of pesticides and mishandling of toxic wastes.

7. *Remember: prevention is cheaper than cure*

Building pollution prevention into new investments is cheaper than adding them on later. New technology is less polluting than old. Developing countries with open markets will be able to gain from importing clean technologies already in use in industrial countries.

sions from mining, gas transmission, and waste disposal.

It is essential that the world community position itself to take rapid, concerted action should the balance of scientific evidence shift toward indicating that stronger concerted action is required. Current discussions concerning a convention on climate change can be important in facilitating such a response.

PROTECTING BIODIVERSITY. Most of the world's species reside in developing countries, but most spending on protection is in industrial countries. Because of the common international concern for biological resources, there is a strong case for more international efforts to provide funding and technical assistance to developing countries.

Effective conservation requires a twofold strat-

egy by host governments and donors. First, complementarities between the goals of development and protection should be exploited. Policies that encourage sound agriculture, off-farm employment, and sustainable logging will also discourage encroachment into natural habitats. Ecotourism, sustainable fishing, and genetic prospecting will be good for development and for biological diversity. Second, specific measures to protect habitats should be adopted, with financial support from industrial countries. Such funding should not be regarded as aid and should not be diverted from aid budgets.

As international funding expands, two concerns will need to be addressed. First, improved coordination among donors is required. The Brazilian Tropical Rainforest Fund, a joint initiative by the Brazilian government and the Group of Seven

(G-7) countries with first-phase financing of \$250 million, is an effort to ensure a coordinated approach. Second, recurrent cost financing will be required for continuous protection, where it does not pay for itself. That the pilot program launched under the GEF cannot easily handle costs of this nature highlights the need for a more durable funding arrangement.

The costs of a better environment

Policies and programs for accelerating environmentally responsible development will not happen by themselves. It is therefore important to seize the current moment of opportunity to bring about real change. The starting point should be policy changes that will promote rising incomes and better environmental stewardship (see Box 4). Some of these changes have little or no financial cost, but their political toll may be high. Subsidies and other interferences with markets are typically supported by powerful interests. The private beneficiaries of subsidies and other market interferences—and those officials who enjoy the patronage of handing them out—will fight to preserve them. Governments thus need to build constituencies of support—by, for instance, publicizing the positive economic and environmental impacts of reforms.

A second set of policies will involve financial costs. Environmental institutions will need to be strengthened, public investments in social and

physical infrastructure and protection will increase, and the private sector will spend more money on abatement. The Report makes broad estimates of costs for key sectors. The additional costs of local environmental programs—many of which would add to employment and income growth—could amount to 2-3 percent of the GDP of developing countries by the end of the 1990s. These expenditures would cover pollution control in energy, industry, and transport and expanded programs of sanitation and water supply, soil conservation, agricultural extension and research, forest protection, family planning, and female education. Although the sums required are high in an absolute sense, they are modest in relation to the benefits they will bring and to the resources provided by economic growth.

Financing the program

The bulk of these investments will be paid for by the customers of the private and public enterprises responsible for the damage and by the beneficiaries of improved environmental conditions. Even so, financing for investment will still be required. In addition, governments will have to spend more on monitoring and enforcement, on research and development, on education, training, and extension, and on protection of natural habitats. Financing for these expenditures will come primarily from increased domestic savings—but international finance will also have a crucial role (Box 5).

Box 5 Complementary guidelines for the international community

1. Adjust aid portfolios

The composition and level of aid programs need to reflect the costs to health and productivity of a damaged environment. Preventing pollution and preserving natural resources are proper goals of aid programs. The strong links between poverty, population, and environmental damage call for higher overall allocations.

2. Invest in research and technological development

Gaps in fundamental knowledge must be filled. Among the priorities for international collaboration are the scale and causes of soil degradation (especially in Africa), the potential of tropical forests for sustainable production, the potential effect of climate change, and technologies for renewable energy.

3. Ensure open trade and investment

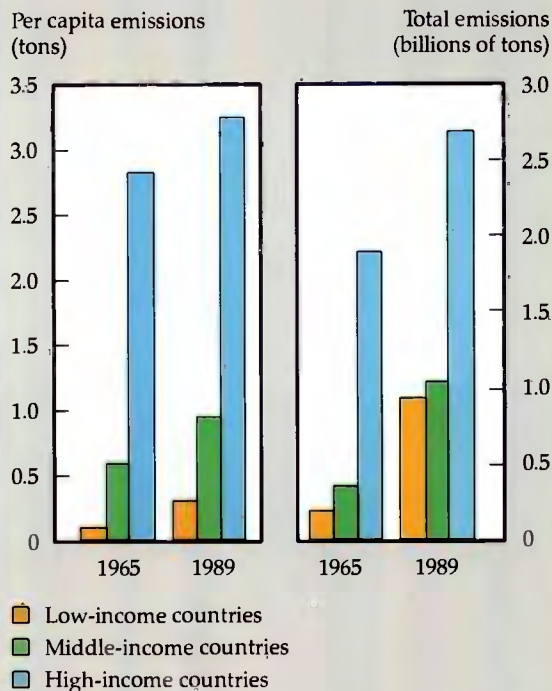
Providing free access to industrial country markets is needed to help developing countries industrialize and grow (both of which are essential for reducing pressure on natural resources) and to enable them to take advantage of less-polluting technologies. An immediate successful Uruguay Round agreement would increase foreign exchange earnings of developing countries by more than the costs of environmental protection.

4. Pay for environmental services

When industrial countries want developing countries to provide environmental benefits (preserving biodiversity, restraining greenhouse gas emissions, and the like), they should be willing to pay compensation. Such funding should be treated as equivalent to payments for imports, not as aid.

Industrial countries are responsible for most greenhouse warming

Figure 6 Global carbon dioxide emissions from fossil fuel consumption and cement manufacturing, 1965 and 1989



Source: Environmental data appendix table A.9.

INTERNATIONAL FINANCE FOR LOCAL PROBLEMS. Access to commercial financial markets—coupled with expanded foreign investment—will be essential to facilitate the technology transfers embodied in capital imports. The encouraging restoration of commercial flows to such countries as Chile, Mexico, and Venezuela over the past two years must be extended to a much wider range of countries. This will require more consistent policies on the part of borrowing countries, which should be supported by debt relief in a number of countries.

Local environmental challenges deserve additional development assistance. Such assistance

should not be viewed as separate from ongoing development needs; rather, it should be embedded in official assistance programs. Development agencies and governments need to place more emphasis on the close link between environmental quality and the reduction of poverty. This warrants additional concessional assistance, particularly in extension, credit, and education programs and in the provision of sanitation services and water supplies to squatter settlements and rural areas. Population programs must be given higher priority; assistance should double in real terms during the 1990s. The close link between the efficiency of resource use and sound environmental policymaking warrants continued support to countries that are undertaking adjustment programs.

FINANCING GLOBAL CHALLENGES. Industrial countries must bear most of the costs of addressing global problems, especially when the required investments are not in the narrow interests of developing countries. Industrial countries account for most emissions of greenhouse gases and CFCs (see Figure 6) and will benefit, along with developing countries, from the protection of natural habitats and biodiversity. It is clearly desirable to create arrangements that make it possible for rich countries to support poor ones in undertaking necessary changes. Such arrangements have the potential to make all countries better off if the world's willingness to pay for policy changes exceeds the cost of the changes. It is imperative that payments under such arrangements not be treated as development assistance or be financed from funds that would otherwise be available for development assistance. They have much more the character of imports—payment for services rendered—and are quite different from aid transfers to developing countries. As a global response to a global challenge, the allocation of such funds should be based on effectiveness in raising global welfare, rather than on meeting national needs.

The agenda for reform is a large one. Accepting the challenge to accelerate development in an environmentally responsible manner will involve substantial shifts in policies and priorities and will be costly. Failing to accept it will be more costly still.