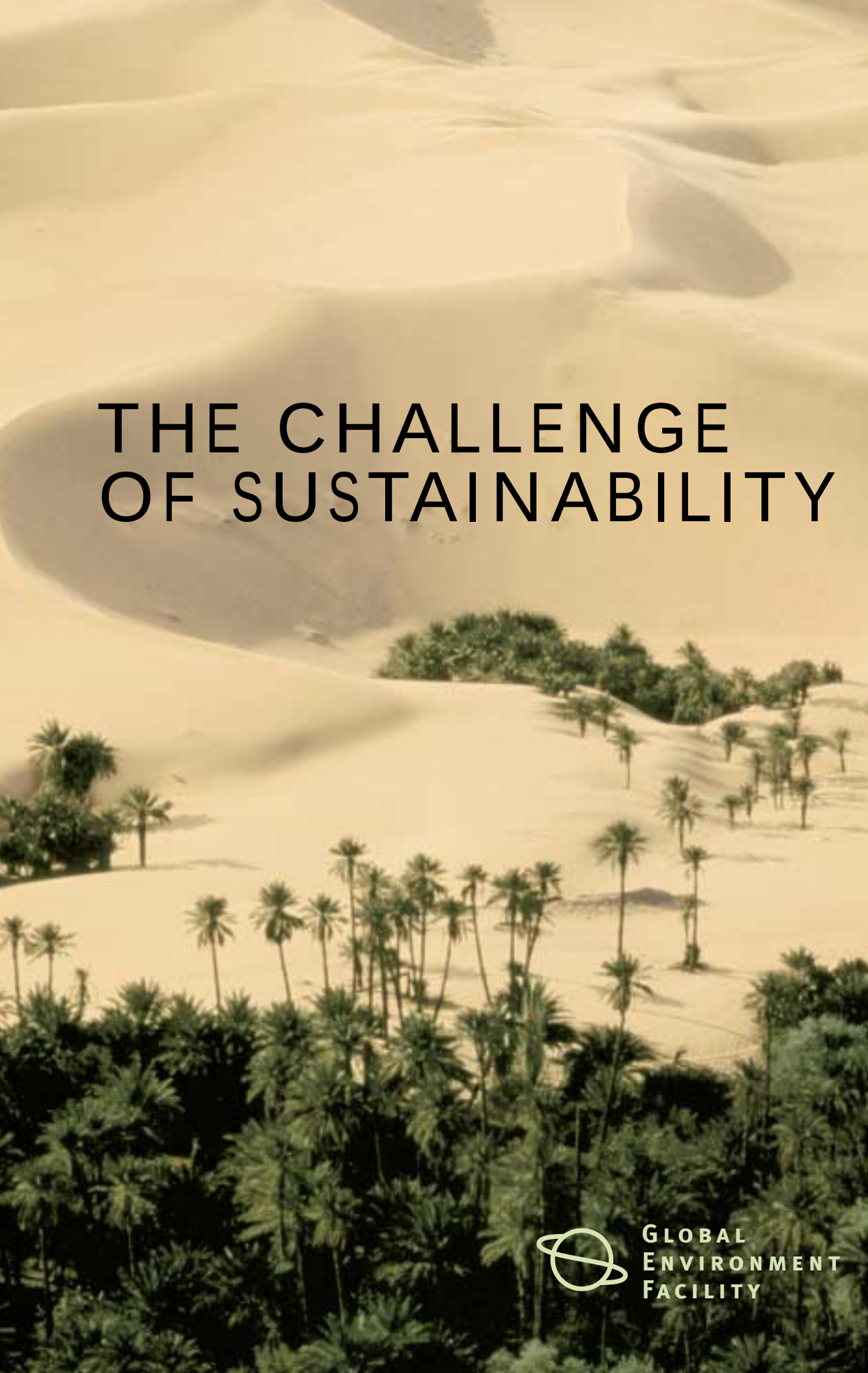
THE CHALLENGE OF SUSTAINABILITY



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THE CHALLENGE OF SUSTAINABILITY

AN ACTION AGENDA FOR THE GLOBAL ENVIRONMENT

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FOREWORD BY
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GLOBAL ENVIRONMENT FACILITY

WASHINGTON, D.C.

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FOREWORD

The human community faces an array of choices about the quality of our lives and the state of the global environment. Each of those choices will help to determine what kind of world our children and grandchildren will live in. One possibility is that at long last we will pave a path toward environmental stewardship and sustainable development. But it is also quite possible that we will travel a less enlightened course, running down the earth's natural capital and severely limiting the choices our descendants will face.

Over the next half-century, we could be:

- A world in which economic and social needs are balanced with the capacity of the earth's resources and ecosystems—or a world impoverished by environmental degradation, where poverty and hunger still afflict a billion or more people.

- A world that properly values water and manages it sustainably—or one that faces widespread water scarcity.

- A world making the transition to renewable energy sources—or one still dependent on fossil fuels, and where climate change is destabilizing many nations.

- A world in which preventable diseases have been largely eliminated—or one in which millions of children continue to die annually because they don't have access to clean drinking water and adequate sanitation.

- A world of responsible consumption and production patterns—or one still inundated by waste and poisoned by hazardous materials.

- A world where rich-country markets are fully open to labor-intensive products from poor countries, and where trade is making significant inroads against poverty—or a world that remains deeply divided between rich and poor.

The legacy is largely ours to shape, and the Global Environment Facility (GEF) will continue to play an important role in this quest. A strategic alliance of the U.N. Development Programme, the U.N. Environment Programme, and the World Bank, the GEF is a unique and innovative source of funding mandated to make the connection between local and global environmental challenges, and between national and international efforts, in order to conserve biodiversity, reduce the risks of climate change, protect the ozone layer, clean up international waters, stop land degradation, and eliminate persistent organic pollutants. Even though its portfolio is still young, and overall funding has been relatively modest, the GEF has made a difference—for example in reducing ozone-depleting substances in Eastern Europe and Central Asia, in combating deforestation and desertification in Sub-Saharan Africa, and in bringing renewable energy to people in developing countries, many of whom live far from existing power grids.

The Challenge of Sustainability: An Action Agenda for the Global Environment has two goals: first, to assess whether the battle to overcome the world's environmental problems is gaining strength, and second, to offer ideas and strategies for the next 10 years. It focuses on the key issues of energy, forests, biodiversity, land and water degradation, and financing. And it proposes practical solutions that build on the World Summit on Sustainable Development and the experiences since the Earth Summit in Rio de Janeiro in 1992. Readers may not agree with every strategy put forth in this report. But we can and must agree on the goals: an end to global poverty and hunger, renewed respect for the environment, and the urgent need for all actors to fulfill their responsibilities to give this generation and succeeding generations a chance to live with dignity and hope for the future.

Kofi Annan
U.N. Secretary General

INTRODUCTION

We have, in the last decade, seen environmental problems mount—from extreme weather patterns and melting glaciers that point to a changing climate, to air and water pollution that threatens human health, to deforestation and land degradation that are undermining the earth's capacity to sustain humanity.

But we have also seen society marshal its resources in an attempt to meet these challenges. Our initial response was slow; it now needs to gather speed as the problems—and the imperative that we meet them—are becoming more clear to us. We now have new tools, and a vastly increased understanding that our strength lies in working together to overcome the threats facing our planet. We can build on these strengths and move ahead with confidence that sustainable development goals are indeed achievable.

This new drive for global sustainability should be rooted in the growing recognition of the strong links between the environment and development. A clean environment is essential for both development and poverty eradication. Unsafe water kills 3 million people each year, many of them children. Sickness and poor health mean lost production for the people and countries that can least afford it. Air pollution also damages the crops, forests, rivers, and lakes that countries need for their economic development.

Environmental and economic inequities are closely interrelated. Poverty pushes the poor into degraded lands and polluted slums, where economic opportunities are minimal. Development that subsidizes sewers, piped water, and electricity for the middle classes and leaves the poor to fend for themselves is more

than unfair; the burdens this places on the poor are reflected in higher health costs, lowered productivity, and the desperate hopelessness that can lead to political instability. A deeper appreciation of this economic and environmental interdependence is essential to tackling the global environmental problems that cloud our future and endanger our health, our security, our natural endowment, and the beauty and splendor of life on earth.

NEW STRENGTHS, REAL ACCOMPLISHMENTS

A decade after the 1992 Rio Earth Summit, we are still struggling to meet and overcome the world's environmental problems, but we are also gaining strength. And our new strengths have been underpinned by real accomplishments. The international community has built new structures of cooperation to meet many of the threats facing our environment. Some governments have extended the time horizons of their development plans to ensure that sustainability underpins future growth. A number of corporations have made eco-efficiency the foundation for their operations. Hard work has translated into laws and treaties, and more hard work has given those laws and treaties the substance and teeth needed to make a difference.

The strength of cooperation first found its voice in the treaties designed to slow and reverse the growing hole in the stratospheric ozone layer. The 28 national signatures on the March 1985 Vienna Convention for the Protection of the Ozone Layer

marked an important milestone: the first time that nations agreed to tackle a global environmental problem before its effects were completely clear. Two years later, general obligations in the convention were further elaborated through the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer. By May 2000, 175 countries had signed on to the Protocol. Developed countries largely eliminated chlorofluorocarbons and halons—the two major ozone-threatening gases—by the end of 1995. And many developing countries are now ahead of the timetable that gives them until 2010 to phase out these two substances.

The Montreal Protocol is a model for international environmental agreements. It is flexible and adaptable, and recognizes the different needs of developed and developing nations. The protocol is the first treaty that incorporates the provision of financing for implementation. The agreement is based on partnership, not confrontation, and has proven an effective way to support economic growth in transitional economies and developing nations.

The lessons we have learned from protecting the ozone layer are being tapped in the effort to reduce the use of energy sources that fuel global warming. Wind, solar, and even tidal power offer both clear commercial opportunities and real environmental benefits. Governments, multilateral assistance agencies, and private investors are building clean new energy systems around the world. Wind power generation capacity has increased from near zero to over 1,700 megawatts. Virtually unknown in 1992, solar home systems using photovoltaic technology now provide power to more than 1 million rural households. And at least 30 major firms have committed to investing $10 to $15 billion in renewable energy over the next five years. Between $500 million and $1.5 billion of renewable energy projects in developing countries are being financed each year, a market with an annual growth of 5 to 10 percent.

Nations are also learning that there is a comparative advantage to working together on the problems they share. The 17 Black Sea and Danube River basin countries, for example, have adopted an action plan that commits them to the policy, legal, and institutional reforms needed for their cleanup effort; they have pledged to install clean technology and reduce organic and toxic discharges by 30 percent in a decade. The 10 Nile River basin countries have established priorities and joint commitments for action to sustainably manage this critical ecosystem. And six Central American countries have joined Mexico in linking their national parks, biological and forest reserves, wildlife refuges, and biosphere reserves in the Mesoamerican Biological Corridor—the first biological preservation project to cross national borders and encompass an entire region.

NEW VOICES, NEW TOOLS, NEW UNDERSTANDING

A hallmark of the past decade has been the recognition that the key actors, operational tools, and political know-how have changed. New voices have joined the effort to forge a more sustainable form of development and help lead the transition to sustainability. And science has given us both new understanding and new tools that have vastly increased our ability to address environmental problems.

The private sector is also playing an increasingly constructive role, an acknowledgment that preserving the environment is both good business and a moral obligation. Companies such as Royal Dutch Shell, DuPont, and BP Amoco are working to reduce their companies' negative impact on climate change and to increase the options for cleaner energy in both developed and developing economies. Many firms have agreed to live by product certification standards. Home Depot, Starbucks, and the British do-it-yourself chain B&Q have focused on environmentally friendly products. CNN founder Ted Turner donated

$1 billion to create the U.N. Foundation, whose mission is to promote a more peaceful, prosperous, and just world by supporting the goals and objectives of the U.N. The Bill and Melinda Gates Foundation helped launch the Global Alliance for Improved Nutrition, an innovative public-private partnership that seeks to provide cost-effective food fortification that promises to improve the health, cognitive development, and productivity of people who live and work in developing countries.

Acting largely through nongovernmental organizations (NGOs), civil society has organized around a new agenda of eradicating poverty and protecting the earth's future. Today's NGOs are skillful communicators, mediators, managers, and intermediaries. They are proficient at using the Internet and e-mail to create international information exchange networks such as the Climate Action Network, which links more than 250 international and national organizations that are actively involved in efforts to moderate climate change. Jordan's Royal Society for the Conservation of Nature is managing conservation of the Dana and Azraq protected areas. And miles away, in the Mankote, St. Lucia's largest mangrove forest, the Caribbean Natural Resources Institute has developed a management plan designed to save the forest while maintaining the incomes of local charcoal producers.

The Global Environment Facility (GEF) is one of the linchpins of these new cooperative efforts. The GEF began as a pilot venture in 1991 and was formally launched in 1994. It finances actions to improve the global environment in several key areas—biodiversity, climate change, international waters, ozone layer depletion, land degradation, and persistent organic pollutants. In its first decade, GEF allocated $4.2 billion in grants, supported by $12.4 billion in additional financing, to more than 1,000 projects in 160 developing and transition nations. In addition, GEF has made more than 3,000 small grants, up to $50,000 each. GEF contributes to global sustainability through partnerships with governments and NGOs at the local, national, and regional levels. It also engages the private sector by removing barriers to private investment, promoting market transformation, using new approaches such as investment funds, and building long-term partnerships. GEF maximizes its impact by supporting the long-term sustainability of investments, encouraging replication, and developing new tools for financial assistance.

OUR PLANET'S FUTURE RESTS ON ITS PAST

The 1992 Rio Earth Summit heralded an unprecedented era of environmental awareness, but the momentum did not always translate into real action on the ground. Progress has been slower than expected, so much must be done to overcome the twentieth-century legacy of environmental degradation that continues to plague us:

- Every year about 15.2 million hectares of forested land in tropical countries are cut down and converted to other uses. The fragmented forests that remain are becoming too small to support viable animal or bird populations.
- Nearly 2 billion people cope daily with the problem of finding enough water, and as many as 3.5 billion—almost half the world's projected population—could face water shortages by 2025. Africa is at particular risk.
- Premature death and illness from environmental health risks still account for 20 percent of the burden of disease in the developing countries.
- At a time when nearly 1 billion people depend on fish as their primary source of protein, the outlook for world fisheries has worsened. Some 75 percent of the world's marine fisheries were judged to be at risk in the 1990s.
- Long-term gains in food production, especially in developing countries, are threatened by land degradation and by growing competition for water from industrial and municipal sources.
- Most of the world's scientists agree that greenhouse gases—notably carbon dioxide from the

burning of fossil fuels—are contributing to a warming climate, which causes shifting precipitation patterns, melting glaciers, and rising sea levels. Developing countries—especially in the tropics and sub-tropics of Africa, Asia, and Latin America—are most at risk, and many are unequipped to adapt to these changes.

One clear lesson of the past decade is that we are all in this together. Both our immediate health and our long-term well-being are linked with that of other species and systems that share and shape our planet. And when we think about nature's gifts to our medicine chest—penicillin, taxol, quinine, and codeine, among other medicines in common use—we can only guess at the significance of losing the plants or insects scientists have not yet identified.

The loss of such potential opportunities could well impact our future well-being, but the threats to life as we now know it are just as sobering. Greenhouse gases—from power plants, automobiles, and burning forests—are agents of climate change. And climate change that disrupts weather patterns can raise sea levels, lower agricultural yields and, in fostering the spread of infectious diseases, imperil human health. Environmental security, then, is a state of dynamic equilibrium between the appetite of mankind and the resources of nature; it is not a construct that any one community or country can assure by itself.

BUILDING ON OUR STRENGTHS

This book measures our new strengths and determination. The chapters that follow examine five of the key challenges we will all face in the coming decades.

The degradation of marine and freshwater resources presents an enormously complex challenge. As Chapter 1 illustrates, partnerships—like the cooperative efforts now under way to clean up the Black Sea ecosystem and sustainably manage the Nile River basin—are the most effective ways to remedy unsustainable uses of large freshwater and saltwater systems.

Food production must increase to feed a growing global population, but ignoring the negative environmental effects of some agricultural practices will only make the challenge more difficult. Chapter 2 focuses on integrated land and water strategies, good management practices, environmentally sound technologies, and policies that can support increases in food production without putting additional stresses on land and water resources.

Chapter 3 provides a frame of reference for responding to the significant changes in the environmental, economic, and political forces that govern forests. Today, questions of institutions and the enabling environment, international standards, and transparency are key issues. Countries now assert their rights to sovereignty over their forests more forcefully than in the past. Some countries are devolving control of forest resources to local communities. The need to manage forests within a large-scale integrated framework has been widely recognized within the past decade, and international mechanisms have been established to improve interagency collaboration on forest issues.

Chapter 4 describes how government and business leaders have changed their thinking about sustainable energy development since the mid-1980s. Actions have centered on three main areas: improved efficiency, increased reliance on renewable energy sources, and efforts to provide more than 400 million rural households with access to modern energy services.

Finally, Chapter 5 explores the new financial resources and mechanisms that are urgently needed to support the global environmental agenda and make progress toward achieving the Millennium Development Goals. Developed countries have a responsibility, at least a moral one, to provide additional financial

resources to support sustainable development, to eradicate poverty, and to improve environmental and human health conditions.

Pursuing a path of sustainable development while protecting the global environment and eradicating poverty is a complex undertaking that will require unprecedented levels of effort, knowledge, and international cooperation. This endeavor depends on the leadership of many people and nations and the balancing of millions of actions and interactions throughout the world. The agenda is truly a global one, and the international community must find ways to re-energize its pursuit of global sustainability and the protection of our global commons. The problems we collectively face are significant—and will deeply challenge our ingenuity and commitment—but there are promising and positive trends that can focus and sharpen our efforts.

Mohamed T. El-Ashry
Chief Executive Officer and Chairman
Global Environment Facility (GEF)

WATER: VALUING A PRECIOUS RESOURCE 1

The global water crisis is not an abstract concept. In many parts of the world, freshwater resources are in critically short supply and are of poor quality. Coastal and ocean waters, and vital resources such as fisheries are similarly stressed. About one-fifth of the world's population lacks access to safe drinking water, and about half lacks adequate sanitation. About 40 percent of the world's population lives in countries with moderate to high water stress. By 2025, this figure could rise to 50 percent.

Yet, with the help of policy and legal reform, international cooperation, community and private sector participation, and technical innovation—there are encouraging signs that the crisis could be averted. For example:

- The international community is beginning to develop a common understanding of the complexity of managing marine ecosystems.
- In high-risk areas such as the Black Sea and the Nile River, nations are working together to devise strategies that will reduce pollution, restore fisheries, and manage resources, while at the same time taking into consideration the interests of both upstream and downstream users.
- South Africa, Brazil, and Mexico have enacted pioneering water laws emphasizing a national approach to water issues.
- Many communities are working cooperatively to manage their water resources.
- New innovative technologies promise significant improvements in water-use efficiency.

- International forums continue to emphasize the importance of management and policy reforms, particularly reducing water subsidies, taking a more integrated approach to water resources management, and using catchments and basin areas as natural management units.

While encouraging, these efforts are still insufficient. Much more needs to be done in five key areas: full-cost water pricing and improved incentives to encourage private sector participation; increased investments for water, sanitation, and health for the poor; greater multinational cooperation on transboundary water issues; stronger efforts to prevent and remedy pollution in coastal waters; and greater emphasis on cross-sectoral approaches and decentralized decision-making on water basin management.

In the Millennium Declaration, the international community acknowledged the importance of global action to increase and protect water resources (Box 1.1). This declaration cogently describes the links between poverty, hunger, and water security and emphasizes the critical role of improved water resources management in sustainable development. Increasing the income levels of the poor will require more water use and the intensive development of marine ecosystems. Growing and harvesting additional food will require more irrigation and greater exploitation of inland and ocean fisheries. Providing more people with safe drinking water will require not only more water, but also enormous investments in sewage collection and treatment systems to reduce disease. Achieving these goals depends on access to water resources—not just access to water.

THE GLOBAL WATER CRISIS

The water crisis has many dimensions and varies considerably across regions. Water supplies are scarce in some regions and relatively abundant in others. And though water quality has improved in many developed countries, it is still a significant problem in most developing countries. The effects of long-term climate change are also likely to vary significantly across regions.

Water Scarcity. Over the past century, world population tripled, but the aggregate use of water rose sixfold. Just 35 years ago, people were using about one-fourth of readily available freshwater. Today they are using roughly half. (Figure 1.1). Most freshwater is used for agriculture (Figure 1.2).

BOX 1.1

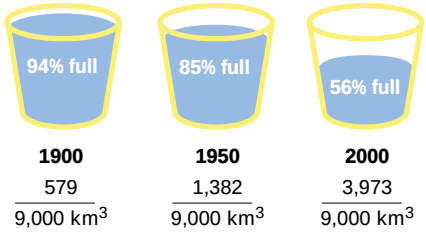
THE MILLENNIUM DECLARATION ON WATER RESOURCES

The community of nations acknowledged the importance of water in one of the goals of the Millennium Declaration:

We resolve further to halve, by the year 2015, the proportion of the world's people whose income is less than one dollar a day and the proportion of people who suffer from hunger and, by the same date, to halve the proportion of people who are unable to reach or to afford safe drinking water.

FIGURE 1.1

The Glass Is Half Full — Water Use, 1900–2000



Full glass = 9,000 km^3 of readily available freshwater.

Source: Shiklomanov, 1999.

It is estimated that about 41 percent of the world's population currently lives in areas characterized by water stress (defined as less than 1,700 cubic meters available per person per year) or water scarcity (less than 1,000 cubic meters per person per year). Assuming the U.N.'s low-range population projection of 7.27 billion people, some 48 percent of the population could be living in such areas by 2025 (Figure 1.3). The World Commission on Water expects that by 2025 water stress will increase significantly in more than 60 percent of the world, including large areas of Africa, Asia, and Latin America.

In the Asia and Pacific region, arid countries such as Afghanistan and the Islamic Republic of Iran already have chronic water shortages. Most other developing countries in the region are faced with growing water scarcity. In many parts of the region, misuse and overexploitation of water resources have resulted in the depletion of aquifers, falling water tables, shrinking inland lakes, and diminished streamflows.

In West Asia, water is a particularly limited resource. In the region as a whole and the Arabian Peninsula in particular, groundwater resources are being withdrawn at rates that far exceed natural recharge rates. In the Syrian Arab Republic, projections suggest that overall demand for groundwater will outstrip the supply by 2005. In the northeastern part of the country, some springs have dried up and the flow of permanent rivers such as the Khabur have been seriously reduced because of groundwater overexploitation.

In Africa, water resources are distributed very unevenly. For example, the Congo River watershed accounts for about 30 percent of the continent's annual runoff but contains only 10 percent of Africa's population. By contrast, the more populous Northern and Southern regions receive just 9 and 12 percent, respectively, of the continent's rainfall. By 2025, it is estimated that nearly half of Africa's population will be living in countries facing either water scarcity or water stress.

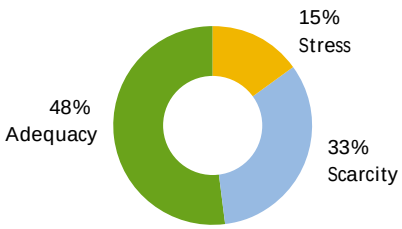
FIGURE 1.2

Agriculture Dominates Freshwater Use

Source: *World Water Vision, 2000.*

FIGURE 1.3

Projected Water Scarcity, 1995–2025



Note: Estimates for 2025 are based on the United Nations' low-range projections for population growth (7.2 billion). Four percent of water is unallocated.

Source: World Resources Institute, 2000.

Water scarcity carries the potential to increase tensions among nations that share water basins. About 43 percent of the world lives in multicountry basins, which cover almost half of the planet's land surface and contain over 80 percent of the freshwater river flow. There are 261 major basins and countless aquifers that cross political boundaries. Most of the river basins in South Asia, South America, and Africa fall into this category. About 50 African rivers—including the Nile, Niger, Volta, and Zambezi—run through two or more countries.

As a result of manmade diversions and extractions, many major rivers no longer reach the sea during the dry season, including the Colorado, Huang He (Yellow), Ganges, Nile, Syr Darya, and Amu Darya. The Amu Darya and Syr Darya rivers once contributed 55 billion cubic meters of water annually to the Aral Sea, but diversions for irrigation have reduced this volume to 7 billion cubic meters, with devastating consequences for the Aral Sea.

Water Quality. About 20 percent of the world's population lacks access to safe drinking water, and about 50 percent lacks adequate sanitation. Since the 1970s, levels of suspended solids in Asia's rivers have risen by a factor of four: they typically contain 4 times the world average and 20 times OECD levels. The fecal coliform count in Asia's rivers is 50 times higher than recommended by the World Health Organization (WHO) guidelines. In Latin America, only about 10 percent of sewage receives any treatment; sewage pollution of groundwater is also common in many developing countries.

Polluted water is estimated to affect the health of about 1.2 billion people every year. It contributes annually to the death of 15 million children under the age of five, and is responsible for 1.5 billion cases of intestinal parasites, 1 billion cases of diarrheal diseases, and 400 million cases of malaria. The WHO reports that about 3.5 million people die from these diseases each year—2.2 million from diarrheal diseases alone. During the month of March 2002, 100,000 new cases of dengue fever were reported in Rio de Janeiro during a wet season, after decades of control. In Africa alone, the annual costs of malaria are estimated at $2 billion; globally, lost productivity from preventable water-related diseases exceeds $100 billion each year.

Sewage pollution is the largest water quality problem, but not the only one. In addition:

- Overuse of pesticides has degraded water quality in many areas.
- Industrial wastes have led to significant water pollution, contaminating water with heavy metals (lead, mercury, arsenic, and cadmium) and persistent organic compounds.
- Over-abstraction of groundwater has led to seawater intrusion along shorelines, causing salinization of coastal agricultural lands.

Non-native invasive species. In many areas, including Lake Victoria and the Black Sea, non-native invasive species have had devastating impacts. The accidental introduction of a jellyfish-like creature into the Black Sea in 1982 soon dominated the aquatic food web, where it directly competed with native fish for food. This, combined with overfishing and other factors, collapsed the Black Sea fish catch to one-third of its former volume by 1992. In Lake Victoria, the introduction of the Nile perch and Nile tilapia had major consequences on the lake's native fish stocks. Invasive plants such as water hyacinths also have proven to be a major problem in many rivers and lakes. As described later in this chapter, strategic partnerships have helped reverse these trends.

Land-based sources of marine pollution. Roughly 75 percent of global pollution of marine waters is from land-based sources. Pollutants include toxic chemicals (organic chemicals, heavy metals, and radioactive waste), nutrients (agricultural fertilizers and sewage), sediments, and solid waste. Nutrient pollution, especially from nitrates and phosphates, is rising dramatically, largely as a result of the excessive use of fertilizers, growth in the quantities of domestic and industrial sewage, and increased aquaculture, which releases considerable amounts of waste directly into the water.

Regional seas such as the Baltic and Black Seas receive massive amounts of pollutants from watersheds that cover a wide geographic area:

- Pollution in the Baltic Sea has been a serious problem for over 50 years. Contributing factors include a high population (about 77 million people in the basin), inadequate wastewater treatment facilities, and emissions from industrial enterprises. Eutrophication and concentrations of toxic organic compounds are growing.

- The Danube, Dnieper, Dniester, and Don rivers carry nutrients, oil, heavy metals, pesticides, and other pollutants into the Black Sea. At risk are the 170 million people who live in the catchment area. In addition, eutrophication and overfishing have decimated the fishery.

Coastal and offshore fisheries. Today the capacity of the global fishing fleet is about 40 percent greater than global fisheries can support. Aided by high-technology fishing gear and other technical advances, the global fishing fleet caught nearly 105 million tons of fish in 1997, more than double the 50 million tons caught in 1975. The marine catch has followed a predictable pattern: as fishing pressure in one region leaves major fish stocks depleted or in decline, the global fleet increases its activities in other fishing regions around the world.

According to the Food and Agriculture Organization of the United Nations (FAO), more than one-quarter of all fish stocks are already depleted, and almost half of all fish stocks are being fished at their biological limit and are vulnerable to depletion.

Climate change and extreme weather events. The dramatic increase in extreme weather events, including both floods and droughts, may be linked to climate change. Between 1986 and 1995, economic losses from natural disasters were estimated to be eight times higher than in the 1960s. The Munich Reinsurance Company recorded 700 major disasters in 1998, compared with between 530 and 600 during previous years. Floods account for about

one-third of natural catastrophes, cause more than half of the fatalities, and are responsible for about one-third of the economic losses. In addition, surface warming of the oceans could reduce phytoplankton productivity, which forms the basis of the entire marine food chain.

Coral reefs. Coral reef systems are declining around the world. While people are becoming aware that these systems are invaluable for sustaining poor coastal communities in the tropics—and are the marine equivalent of rain forests in terms of sheltering immense biodiversity—little is being done to reduce human pressures.

Recent assessments have found that up to 60 percent of reefs worldwide are threatened by human activities. Overfishing, destructive fishing with explosives or poisons, sewage, and sedimentation are responsible. In some countries, such as the Philippines and Thailand, up to 80 percent of corals are already degraded. Extensive coral bleaching also has recently been linked to the warming of surface waters; these trends may be linked to climate change.

Several initiatives are under way to help slow this decline. The International Coral Reef Initiative, started in 1995, stresses the need for integrated coastal management to minimize the detrimental effects of coastal development. And at the national and local levels, a number of governments and communities have taken steps to protect and restore coral reefs.

WATER, HEALTH, AND POVERTY

The links between water, health, and poverty are numerous and complex. Issues include lack of access to safe water and adequate sanitation, the amount of time spent by rural women to obtain water, the higher risk of waterborne disease in poor communities, and the fact that the urban poor often must buy water from vendors that costs 10–20 times more than piped water.

Access to saltwater resources is another key element for poverty reduction. Many coastal communities depend on harvesting living marine resources for income and for food. About 40 percent of the world's people live in coastal and riverine floodplain areas and are critically dependent on fish and other marine products. In the Pacific Ocean region alone, coastal settlements account for about 60 percent of the population.

In many cases, water development and other projects have in the past compromised the security of poor communities by reducing or eliminating their access to water or by increasing their vulnerability to flooding. Redressing the denial of traditional formal or informal property rights has been neglected or ignored in some nations. But many countries now realize that the security of poor communities often depends on access to water ecosystems such as functioning wetlands and floodplains. Three important dimensions of poverty reduction include:

- Protecting and expanding the asset base for the poor
- Improving land tenure regimes and securing water rights
- Expanding social protection and community participation, especially by women.

FORGING A COMMON UNDERSTANDING

Countries are increasingly recognizing the advantages of working together to manage transboundary basins and marine ecosystems. Solutions have already been developed to reduce ship-related pollution, expand general policies on wetlands, and control movement and disposal of hazardous wastes.

A growing number of countries now support international conventions that recommend norms, targets, and compliance measures. The goal of the U.N. Convention on the Law of the Sea (UNCLOS) and the U.N. Convention on the Law of Non-Navigational Uses of International Watercourses is to implement global solutions through region-specific partnerships among nations experiencing problems. Regional cooperative efforts—such as those targeting the North Sea, the Danube River and Black Sea, the Rhine basin, Lake Geneva, and the Senegal and Okavango River basins—are pragmatic models for how the world community can address these issues.

UNCLOS, which entered into force in 1994, sets out the rights and duties of states with respect to the use and conservation of the oceans and their resources. This document includes fundamental global norms for conservation of marine resources and for preservation and protection of the marine environment. These global norms are translated into more specific goals and commitments through specialized agreements. For land-based sources of pollution, for example, the UNCLOS framework calls on governments to establish detailed rules and guidelines and to harmonize policies at the regional level. Several regional seas agreements have specific language on land-based pollution.

The U.N. Watercourses Convention adopted in 1997 has yet to enter into force. It represents a global framework agreement designed to ensure the safe use, development, conservation, management, and protection of international watercourses.

Non-binding "soft" law complements binding legal arrangements, helping countries overcome barriers to action. The Global Programme of Action (GPA) for the Protection of the Marine Environment from Land-Based Activities is an example of such soft law. Adopted in late 1995, GPA recognizes that more than 75 percent of coastal and marine water pollution originates from land-based sources. In addition to pollution loading, GPA addresses the modification of physical habitat, such as wetlands conversion, in establishing priority action areas and defining strategies and programs to take advantage of numerous instruments that currently exist. Other prominent international action programs have been adopted in accordance with the FAO Code of Conduct for Responsible Fisheries.

In recent years, numerous international forums have sought to galvanize the plan of action originally outlined in Agenda 21, the global action plan for sustainable development adopted at the 1992 Rio Earth Summit. In the freshwater area, these include the deliberations of the World Commission on Water for the 21st Century, the second World Water Forum in the Hague in 2000, and the International Conference on Freshwater in Bonn in 2001. In the marine area, an Intergovernmental Review Meeting was held in Montreal in November 2001 to assess progress under the GPA, and two important conferences reviewed progress on addressing marine fisheries and coastal management. The GPA Intergovernmental Review Meeting, the Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem, and the Paris Conference on Oceans and Coasts at Rio Plus Ten all confirm the path laid out in Agenda 21.

These important global policy discussions, and the new tools that have emerged from a decade of experience, have led to consensus on an action agenda that addresses poverty reduction as well as water-related human health and governance issues. The agenda covers both freshwater and marine systems and fosters integrated approaches for linking the two. It also recognizes the need to consider land and water management within the

framework of catchments, and supports further land tenure reforms and stakeholder participation. An important part of the agenda is the establishment of country-driven partnerships between developed and developing nations to foster the transition to sustainable development that is consistent with the multiple-use, public goods nature of our planet's water ecosystems.

PROMISING STRATEGIES

The many promising strategies for water resources management include regional partnerships, policy and legal reforms, community participation, integrated approaches, and technical innovation.

Regional Partnerships

In cases involving shared river basins and regional seas, cooperation among affected nations is the only way to successfully attack pollution and water resource management problems. Two pioneering examples involve the Black Sea and Danube River, and the Nile River.

Black Sea and Danube River. Following the signing of the Danube and the Black Sea regional conventions, the 17 participating countries carried out projects funded by GEF to build capacity, help identify needed policy, legal, and institutional reforms, and establish priorities for investments in the agricultural, municipal, and industrial sectors. To accelerate implementation of these reforms and investments, the GEF Council approved the first $29 million of a $95-million Strategic Partnership for the Danube and Black Sea Basin. The partnership harnesses the comparative advantages of each of the three GEF implementing agencies—the U.N. Development Programme (UNDP), the U.N. Environment Programme (UNEP), and the World Bank—to help the countries address top priorities that complement actions funded through the European Union. The partnership is leveraging three times the GEF

contribution through cofinancing to assist the countries in this region.

Wetlands were also considered a priority for accelerating restoration of the river and sea. In Romania, for example, wetlands between the villages of Chilia Veche and Periprava were drained in the early 1980s to increase agricultural production, which in turn destroyed fishery habitat and valuable reeds traditionally harvested by local people. After a GEF-supported project breached the dike in four places, 20 species of fish returned to the wetlands in just two years, and the reed bed regained its former health. A project on the island of Cernovka had results that were just as striking.

The Nile River. Following six years of preparation, the 10 Nile Basin countries launched the International Consortium for Cooperation on the Nile in June 2001. The consortium received pledges from the donor community for an initial $140 million for the Shared Vision Program of the Nile Basin Initiative, with an additional $3 billion anticipated in investments for sustainable development. GEF played a significant role by providing preparation funds for the formulation of a GEF international waters project that would underpin the initiative.

The consortium produced a transboundary environmental analysis to build confidence and set priorities. This analysis was produced through a participatory process and included in-country consultations, national reports, and in-country interministerial coordination. The Transboundary Environmental Analysis was approved by the Nile Council of Ministers in March 2001, marking the first time such a substantive document received approval of all Nile riparian countries. This catalytic process proved to be a turning point for expanding the dialogue among the water ministries to include other ministries in each of the 10 countries as well as NGOs. The transboundary analysis process was so successful that it became a model for other parts of the program piloted through the GEF. In 2001, the GEF Council approved the first tranche of $11 million for the Nile Basin Initiative.

Managing Large Marine Ecosystems

Like the Black Sea and Nile River cases, partnerships are being used to enhance the management of large marine ecosystems.

For example, the Benguela Current Large Marine Ecosystem (BCLME), which is shared by Angola, Namibia, and South Africa, provides annual benefits worth hundreds of millions of dollars. This globally important fishery has been stressed by overfishing, oil and gas extraction, and diamond mining. But it is also threatened by extreme weather events. In the 1980s, scientists found changes in the Benguela that were related to increased temperatures and currents. The fisheries and the region's sensitive biodiversity, including penguins and seals, were adversely affected.

The three BCLME countries received GEF assistance in 1998 to prepare a Strategic Action Programme of reforms and actions to sustainably manage the large marine ecosystem and its biological diversity. The countries will enact policy, legal, and institutional reforms to jointly manage the large marine ecosystem and to address mineral and energy extraction issues. This international waters program was formed in partnership with BENEFIT, a science-based capacity building program funded by European nations.

Legal Reforms

Several nations—including South Africa, Brazil, and Mexico—have recently enacted national water laws that take a new approach to water resources management.

South Africa. South Africa's 1998 National Water Act is a pioneering effort to incorporate sustainability and international cooperation into a national water law.

The law reflects the growing consensus among South Africans that further expansion of water supplies is unrealistic. South Africa is already using nearly 60 percent of its available water, compared with just 5–10 percent in countries such as Namibia

and Botswana. Furthermore, South Africa's water resources are greatly influenced by climate and topography. Only one-fourth of the nation has perennial rivers, another fourth has rivers that only flow periodically, and half of the nation has rivers that only flow after infrequent storms.

The law's objective is to "manage the quantity, quality, and reliability of the nation's water resources… to achieve optimum long-term, environmentally sustainable, social and economic benefit for society from their use."

Under the new law, water is specifically reserved for two priority uses: to meet basic human needs and to maintain ecological functions. Provisionally, the law allocates 25 liters a person a day to each individual for drinking, food preparation, and personal hygiene. The law also seeks to balance human use with the long-term sustainability of aquatic and associated ecosystems throughout South Africa.

Remaining water must be allocated so that all people have equitable access—for productive purposes and for benefits that flow from water use, such as jobs. The new law greatly broadens local participation in water management decisions. Within an individual watershed, the responsibility for allocating water to users rests with local catchment management agencies, which are expected to operate with broad participation from all interested parties.

The Department of Water Affairs and Forestry is authorized to develop water pricing strategies, such as charges to cover the full financial costs of providing access to water, including infrastructure; a watershed management charge, which can cover the use of rivers and water bodies for both water consumption and waste disposal; and a resource conservation charge, which can be applied when a particular water use significantly affects others in the watershed. Finally, the law recognizes the need to manage transboundary water resources cooperatively.

Brazil. Brazil enacted a new water law in 1997 and a national system of water resource management in 1998. Under the new law, Brazil adopted the river basin as the basic territorial management unit. Rivers that lie wholly within a state are now the responsibility of that state, while the federal government is responsible for rivers that cross more than one state.

Basin committees for state and federal rivers are the focal point for the development of a water resources management system. Federal government approval is not required, so basin committees decide how much and when to charge for the use of rivers. They establish charging mechanisms, suggest values to be charged, and determine the criteria for the distribution of costs linked to projects that have multiple uses or that are of common or collective interest.

The pricing provisions of the law are intended to promote recognition that water is a real asset, make consumers aware of its economic value, motivate the rational use of water resources, and obtain funding for programs and activities that are required in water resource plans.

Mexico. In Mexico, the 1992 National Water Law is based on an integrated ecosystem-based approach to the modernization of water resources management. The law authorizes the establishment of river basin councils to coordinate activities and produce agreements among the National Water Commission, other federal, state, and municipal agencies, and water user representatives. The National Water Commission also has reorganized its regional structure, with boundaries based on river basins (see Chapter 2).

Community Participation

There are many opportunities to reduce poverty through sustainable, community-based fisheries management. In southern India, the Gulf of Mannar Biosphere Reserve includes 21 islands with 44 villages and a total population exceeding 100,000. A GEF project implemented by the UNDP set up 20 village marine conservation councils (VMCCs) to ensure stakeholder consultations. About half of these

council members are women. Working with existing village *panchayat* councils, the VMCCs established user-rights agreements between the government and fishing cooperatives, including trawlers. In addition, the project contracted with a local NGO to manage a microcredit scheme to support mariculture and sustainable fisheries.

In the GEF's Lake Victoria project, improved management of land and water resources has been the cornerstone of demonstration activities in Kenya, Tanzania, and Uganda, the three nations that share the lake. Local communities were actively engaged by their governments to address illegal fishing activities, secure access rights, implement biological controls for water hyacinth infestations, reduce water-related disease risks, and form beach management committees. With GEF assistance, Kenya mobilized 185 beach committees, Uganda 82, and Tanzania 510 to contribute to improved management of the transboundary resource.

The Lake Victoria export fishery is now recovering, with the return on investment estimated at $600 million over two years.

In India, the Centre for Science and Environment (CSE) is sponsoring a national campaign to promote the use of rainwater harvesting. The campaign includes a website (*www.rainwaterharvesting.org*); training programs for masons and plumbers on implementation of rainwater harvesting; on-site visits to local communities that harvest rainwater; and numerous publications.

CSE's National Water Harvester's Network, which promotes community water management programs based on water harvesting, has members and affiliates throughout India. With groundwater levels declining in many parts of India, rainwater harvesting is gaining political support. In November 1998, President K.R. Narayanan invited CSE to suggest measures to harvest water at Rashtrapati Bhavan,

the presidential estate. An elaborate plan for water harvesting is being implemented on the estate. In addition to these examples, community-level action programs also could include:

- Watershed protection programs in which local people work with NGOs and research organizations to promote conservation and local empowerment
- Local councils that tackle local water rehabilitation and pollution problems
- Basin-level organizations for integrated water management
- Construction of groundwater recharge wells to improve village water supplies and aquifer management
- Disaster preparedness linked to community action
- Drought relief efforts that mobilize work and food supplies
- Community action to control waterborne disease
- Local monitoring of water quality, crop selection, and quality control of produce irrigated with effluent water.

Public-Private Partnerships

There are encouraging examples of the private sector working with urban and rural communities to provide affordable water supply services and sewage treatment collection systems. Some companies work with community groups to plan the services, and community labor helps to reduce the costs.

Following the adoption of South Africa's water law, for example, a number of pilot partnerships were launched to test low-cost techniques for delivering water to both rural communities and those on the outskirts of cites such as Durban. Although these public-private partnerships were established for an affordable fee, the water still remains under the regulatory control of the government as a public good. In rural areas of South Africa—the Eastern Cape, Northern Province, KwaZulu/Natal, and Mpumalanga—over 2 million people have been served since 1997 in a BOTT (Build-Operate-Train-Transfer) Partnership. Standpipes that use electronic pre-payment cards and those financed through community revenue collection

provide water from wells and from an extensive scheme of 50 reservoirs. The transfer of these services to local companies resulted in sustainable operations and fee collections even in rural areas.

In poor sections of Durban, community groups' participation in urban planning created a demand for affordable sewage collection systems. In 1999, a partnership was initiated to use labor from the communities to reduce the cost of shallow, small-bore sewer systems similar to ones popularized in Brazil. The resulting 50-percent savings in capital costs made extending sewerage systems affordable. These private-sector partnerships overcame years of inaction and inequities experienced by poor communities in South Africa.

Innovative Irrigation Technologies

Options to improve the productivity of irrigation include land leveling and efficient sprinklers to apply water more uniformly; surge irrigation to improve water distribution; low-energy precision application sprinklers to cut evaporation and wind drift losses; furrow diking to promote soil infiltration and reduce runoff; and drip irrigation to cut evaporation and other water losses and to increase crop yields (see Chapter 2).

Changes in water management systems are also important. For example, irrigation systems could be improved through better timing of water releases. Farmers could adopt water-conservation technology and use better information and communication technologies to reduce non-beneficial irrigation, apply water uniformly to crops, and reduce stress. Farmers could also plant more drought-resistant crop varieties or varieties that use water more efficiently. In addition, they could adapt better soil management and other conservation practices.

Conserving Ecosystems

Sufficient water must be set aside to maintain ecosystem health and services. Upstream, the management of forests and land is essential for moderating hydrological variability, reducing silt, and conserving biodiversity. Downstream, water is vital for the conservation and management of wetlands and floodplains and to support fisheries and crop production systems.

In Australia, for example, the states in the Murray-Darling River basin have agreed to allocate 25 percent of the river's natural flow to maintaining the system's ecological health.

Many water utilities and hydropower companies are developing partnerships with upstream communities for maintenance of catchment quality. In Ecuador, a variety of groups have joined together to protect the catchment area above Quito. In 1998, the project leaders established a fund for the protection of the catchment. Water consumption fees will be negotiated with the various users and invested in catchment protection. The project sponsors include the Nature Conservancy, the Ecuadorian Forest and Natural Areas Institute, Quito's Municipal Sewage and Water Agency, and other companies and local groups in the Quito area.

In downstream areas, new practices include incorporating ecological flows in the design of new infrastructure and recalibrating the operating rules in river basins. The Lesotho Highlands Water Project in South Africa is a recent example of how better management of river flows can provide both ecosystem and economic benefits. Restoration of the Lesotho River floodplain enabled traditional subsistence users to improve their liveihoods (see Chapter 2).

Streamflow regulation is another important component of watershed management. Developed countries have historically relied on massive infrastructure (dams, levees, and canals) to control streamflow and manage floods. More recently, nonstructural solutions, such as watershed management and land use planning, have proved to be effective complements to traditional infrastructure. Many developing countries also are investing heavily in nonstructural solutions.

Ecosystem-based irrigation management is built on the needs of the ecosystem and the watershed's inhabitants. For example, in Western Africa, a dam constructed in 1978 for rice irrigation in Cameroon severely restricted the downstream floodplain along the Logone River, causing ecosystem degradation and the disruption of traditional livelihoods. In 1988, The World Conservation Union (IUCN) initiated a project to rehabilitate the Logone floodplain. The restored floodplain is providing important new economic benefits for traditional users (see Chapter 2).

AN ACTION AGENDA FOR WATER RESOURCES

The last decade has seen a growing acceptance of changes in management policies and institutions that are necessary to sustain freshwater and ocean ecosystems. At the same time, there is a new recognition that fluctuating climatic conditions can pose long-term threats to the benefits these water-related ecosystems provide for both national economies and local communities.

An action agenda to address these new realities must ensure access to freshwater and marine ecosystems for the poor; recognize water-related human health issues (including sanitation, hygiene, and sewage-related pollution) by enacting reforms and incentives for improved service delivery; reduce subsidies and phase in full-cost water pricing to generate revenue and attract private sector participation; and establish transboundary and large marine ecosystem-specific partnerships to undertake reforms and foster investments that can reverse existing trends in pollution and depletion.

The agenda for freshwater and marine ecosystems—drawn largely from the recommendations of the World Commission on Water—must include these specific steps:

Enacting National Policy, Legal, and Institutional Reforms. National water laws should be amended to incorporate policy, legal, and institutional reforms for improved governance of water resources, including transparent water rights and allocation systems, the phase-in of full-cost pricing policies for water service delivery, and integrated land and water resources management on a basin scale with stakeholder participation. "User pays" and "polluter pays" principles in pricing reforms will help meet ecosystem standards, promote water-use efficiency, emphasize demand management, generate revenues, and attract large investments from the private sector, including graduated tariff structures for serving poor communities. The phase-in of full-cost pricing policies will serve as the basis for promoting conservation, reducing waste of precious water, and mobilizing resources. Water charges collected for water use will raise revenues for national water resource investments.

Investing in Health and Water Quality Improvements. Governments, donors, and international financial institutions should double their annual investments to improve water supply, sanitation (including innovative ecological sanitation), and health hygiene, with a much greater emphasis on rural communities. In the past, donors and governments have emphasized the provision of water quantity, with disappointing results in human health.

In addition to direct investments, international financial institutions should leverage a fivefold

increase annually for infrastructure and services to improve health and water quality. Through widespread use of innovative financial instruments, these institutions could catalyze public-private investment, with a priority on reduced costs for services in poor urban communities. Partial risk guarantees (and partial credit guarantees to municipal governments) will catalyze private sector investments in low-cost technologies for urban water and sewage treatment. To gradually ease tariff increases to cost-recovery levels, international financial institutions should adopt "output-based lending" to reflect the public goods nature of both health and water quality improvements and sewage pollution abatement.

Improving Water Use Efficiency to Protect Ecosystems. Governments, donors, and international financial institutions should redirect the approximately $33 billion annual expenditure on irrigation improvements. The funds should be used to improve the productivity of rain-fed and irrigated land in an effort to balance conflicting uses of water within river basins, especially during times of fluctuating climatic conditions. Improved productivity should be encouraged through the use of water efficient technology, water user organizations, pricing policies, and productivity gains. Investments in low-cost agricultural technologies can provide important benefits for the poor. The human-powered treadle pump and other cost-effective options are available to improve the productivity of irrigation (see Chapter 2).

WATER TARGETS FOR 2015

- Enact legal reforms in national water laws in 50 percent of all countries by 2005, 90 percent by 2015.
- Implement integrated management of river basins in 90 percent of all countries by 2015.
- Cut in half the number of people who cannot reach or afford safe drinking water, and who do not have access to hygienic sanitation by 2015.
- Reduce by 20 percent the number of urban dwellers who do not have treated sewage by 2015.
- Develop country-driven partnerships with national and international support for one-third of the world's 64 large marine ecosystems and 276 major transboundary basins by 2010, with implementation under way by 2015.

Placing New Emphasis on Partnerships for Transboundary Freshwater Basins. Governments should use international financial institutions and donor assistance to establish multicountry partnerships for improving the governance of transboundary water resources. Country-driven partnerships for the sustainable development of shared systems—such as the GEF-sponsored Nile River Basin Initiative—will yield domestic, regional, and global benefits. Such partnerships can improve ecosystem access for the poor, reduce disease, improve water quality, promote adaptation to fluctuating climatic regimes, and facilitate transboundary freshwater basin collaboration for water security. Reallocation of phased reductions in OECD agricultural subsidies, and increased national use of the World Bank's Heavily Indebted Poor Countries (HIPC) Initiative to conserve natural capital, will provide sufficient financing for such partnerships.

Fully Implementing Existing International Agreements on Marine Systems. Full implementation and effective compliance with existing international agreements on marine ecosystems are imperative to reduce overfishing, fleet overcapacity, bycatch rates, and habitat destruction in coastal areas. For both OECD and developing countries, it is essential to enact policy, legal, and institutional reforms through new coastal/marine legislation. Goals should include effectively imple-

menting compliance with international agreements, authorizing integrated coastal management, establishing systems of strategically situated marine protected areas, and reducing excessive loading of nitrogen from land-based sources. Ecosystem-based approaches are necessary to achieve the integrated management needed to reverse pollution and depletion.

Supporting Partnerships for Sustaining Large Marine Ecosystems. Donor nations, developing countries, and international financial institutions should establish strategic partnerships for the management of large marine ecosystems. Multicountry partnerships are essential to ensure collective shareing of benefits. The GEF-sponsored Strategic Partnership for the Danube and Black Sea Basin and the Benguela Current Large Marine Ecosystem are examples of the types of partnerships needed to make the transition to sustainability. The GEF will continue to assist collaborating nations in their efforts to work together to address existing and potential threats to water resources.

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LAND, WATER, AND FOOD PRODUCTION: MOVING TOWARD SUSTAINABILITY 2

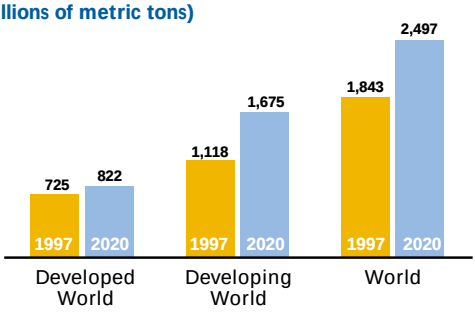
Over the next several decades, the developing world will face growing pressures on its land, water, and food production systems. The principal driving forces will include population growth, with world numbers projected to rise to perhaps 7.5 billion by 2020; income growth, which will fuel rising food demand; and the continuing effort to help the more than 800 million people who currently do not get enough to eat to lead healthy and productive lives.

In response to these pressures, the world's farmers—particularly those who eke out a living on small farms in developing countries—must substantially increase their crop production. The International Food Policy Research Institute (IFPRI) currently estimates that demand for cereals in developing countries will increase by nearly 50 percent from 1997 to 2020, rising to nearly 1.7 billion metric tons (Figure 2.1). China and India are expected to account for about 40 percent of this increased demand (Figure 2.2). Over the same period, the developing world's appetite for meat will nearly double, rising to 213 million metric tons, although per capita consumption of meat in these countries will still be far below levels in the developed world (Figure 2.3).

Will developing countries be able to continue the remarkable production gains that have occurred since the 1950s? Those successes were built largely on new plant varieties, more inputs, and more water. World fertilizer use climbed from 14 million tons in 1950 to 134 million tons in 2000. Land under irrigation increased from 90 million

FIGURE 2.1

World Demand for Cereals, 1997 and 2020
(millions of metric tons)



Source: IFPRI IMPACT projections, June 2001.

hectares in 1950 to about 264 million hectares by 2000. Plant breeders produced a steady stream of new, more productive varieties; in rice, for example, more than 2,000 modern varieties have been released since the 1960s, and progress is continuing. For the world as a whole, land productivity has nearly tripled since 1950. Fisheries also contributed to the food success story. With dramatic increases in investment and fishing effort, the oceanic fish catch increased from 19 million tons in 1950 to 86 million tons in 1998.

In many cases, however, these gains were built on a fragile foundation. They can often be traced to policies that emphasized national food self-sufficiency at the expense of sustainable resource management. Trade policies, output price policies, and input subsidies—notably for water, fertilizer, and energy—all contributed to unsustainable use of the land.

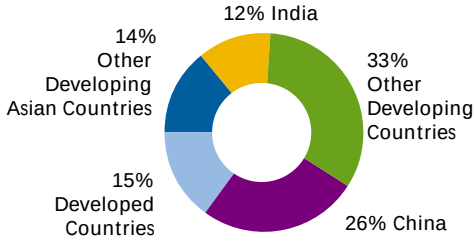
During the last two decades, the environmental costs of these national food policies have become painfully obvious. In Asia, intensive rice monoculture has contributed to the degradation of the paddy resource base. Problems include the buildup of salinity and waterlogging, use of polluted groundwater, nutrient depletion and mining, increased soil toxicity, and increased pest buildup, especially soil pests. In India, salinization affects an estimated 4.5 million hectares, and waterlogging impairs a further 6 million hectares.

Moreover, the options for using land and water resources seem to be narrowing:

- Further cropland expansion is not likely, particularly in Asia.
- New irrigation development has slowed since the 1970s, and competing demands for water from municipal and industrial users will limit the expansion of irrigated agriculture.
- The rate of growth of cereal yields has slowed.
- Most marine fisheries are deeply stressed; about 75 percent of the world's marine fisheries are at risk, up from 69 percent at the end of the 1980s.

FIGURE 2.2

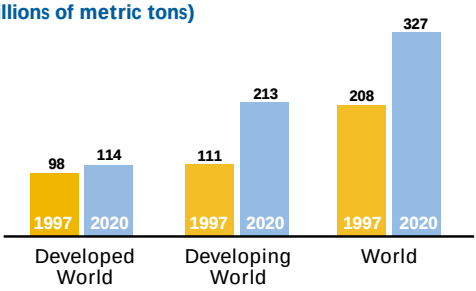
Increased Cereal Demand, 1997–2000



Source: IFPRI IMPACT projections, June 2001.

FIGURE 2.3

World Demand for Meat, 1997 and 2020
(millions of metric tons)



Source: IFPRI IMPACT projections, June 2001.

IFPRI currently predicts that farmers in the developing world will be unable to keep up with rising demand. Net cereal imports by developing countries, largely from the United States and Europe, are likely to more than double by 2020. China's cereal trade deficit could nearly double by then, rising from 89 million metric tons, while India could shift from near self-sufficiency to requiring imports of 30 million metric tons. By 2020, India's agricultural trade deficit could rise to $9.1 billion, and China's to $33.5 billion.

Sub-Saharan Africa faces a particularly difficult challenge. There, agroclimatic constraints are more difficult than in much of Asia; the cost of accessing water is higher; and irrigation, transportation, and communications infrastructures are far more limited. Other factors—widespread political instability, the HIV/AIDs crisis, rapid population growth, and relatively slow economic growth—also will make it hard for many African nations to muster the needed investments and policy reforms to increase food production. IFPRI forecasts that Africa's food bill could rise from $6.5 billion in 1997 to $11 billion by 2020. Paying that off could be politically and economically unsustainable. If African nations are unable to pay for needed imports, food shortages and malnutrition could rise to catastrophic proportions.

Faced with such daunting food bills, the pressures on farmers in developing nations to increase productivity—at the likely expense of the environment—are sure to increase. A critical challenge in the next few decades will be for these countries to adopt integrated land and water strategies, good management practices, environmentally sound technologies, and better policies to support food production increases without putting potentially disastrous stresses on land and water resources.

As an institution concerned about global environmental problems, GEF recognizes the many significant linkages between agricultural practices and the global environment. Groundwater overpumping, nutrient runoff into surface waters, and the conversion of forests to cropland all have significant global environmental implications. Taking steps to reduce these environmental problems can likewise create significant global environmental benefits.

NARROWING THE OPTIONS

The strategies used to produce the massive food production gains of the last several decades may not be sufficient for the task that lies ahead. Moreover, environmental degradation and other factors—including the rising incidence of conflicts and natural disasters—are combining to produce significant production constraints (Box 2.1).

Land Degradation

On about one-fourth of the world's agricultural land, soil degradation is widespread, and the pace of degradation has accelerated in the past 50 years. In developing nations, productivity has declined substantially on about 16 percent of agricultural land—especially on cropland in Africa and Central America and on pastureland in Africa. The annual loss of agricultural land due to degradation is thought to range from 5 million to 12 million hectares, or about 0.3–1.0 percent of the world's arable land.

Estimates of the effect of degradation on agricultural productivity vary, but clearly the impact is significant in some regions. From 1945 to 1990, the cumulative crop productivity losses from land degradation have been estimated at about 5 percent worldwide, which is equivalent to a yield decline of 0.11 percent per year. In Africa, however, it is estimated that cumulative crop yield reductions due to past erosion averaged about 8.2 percent for the entire continent and 6.2 percent for Sub-Saharan Africa.

Water Scarcity and Degradation

Water resources are critical to food security, yet water is already scarce in many parts of the world (see Chapter 1). Water shortages are a significant problem in Africa, Northern China, parts of India, Mexico, and the Middle East.

BOX 2.1

CONFLICTS AND NATURAL DISASTERS

Conflicts and natural disasters have caused significant losses to farmers and badly damaged the agricultural sector in many countries.

Conflicts have increased from an average of 5 a year in the 1980s to 22 in 2000. In recent years, conflicts have occurred primarily in the least-developed nations of Africa, but also in the Middle East, the Balkans, Central America, and Asia. In 23 countries where data were available, it is estimated that the impact of conflict on agriculture amounted to almost $55 billion between 1990 and 1997. In 1997, conflicts accounted for an estimated 40 percent loss of agricultural GDP in these countries.

Similarly, the number of countries affected by disasters rose from 28 in 1996 to 46 in 2000. Further, the scale of damage from natural disasters has increased. Major storms and floods have struck China, Bangladesh, Vietnam, Cambodia, India, Southern Africa, Central America, the Caribbean, and Venezuela. Floods preceding a drought were also a significant cause of the intense food shortages that affected parts of the Horn of Africa in 2000. Economic losses from the great floods of the 1990s are 10 times those of the 1960s in real terms. There has been a 37-fold increase in insured losses since the 1960s.

In 1998, total damages from natural disasters were estimated at $89 billion. About 32,000 people were killed, and 300 million were displaced from their homes and livelihoods.

Source: FAO.

Agriculture plays a major role in water use, accounting for more than 70 percent of water withdrawals worldwide and more than 90 percent in low-income developing countries. By 2025, total water withdrawals for agricultural, domestic, and industrial use are projected to increase significantly in more than 60 percent of the world, including large areas of Africa, Asia, and Latin America. Greater demand from domestic and industrial uses is likely to reduce water supplies for agriculture. Increasing water scarcity will be a primary cause of a slowdown in the growth of irrigated cereal yields in developing countries.

Many existing water management practices are unsustainable. Millions of hectares of irrigated cropland have been damaged by waterlogging and salinization as a result of poor water management. In India and elsewhere, groundwater extraction often exceeds the rate of natural recharge. In some areas, shallow aquifers are almost depleted; scarcity and quality problems often are linked. Groundwater pumping can extract water that is saline or contains natural contaminants such as arsenic or fluoride. When combined with increasing pollutant loads from industry and municipal sewage, this pumping can irreversibly contaminate aquifers.

Water-level changes and fluctuations are another important factor influencing access to groundwater. When levels drop below an economically recoverable range, farmers lose access to irrigation, households are deprived of drinking water, and surface water bodies and wetlands are adversely affected.

Cropland Area

Putting more land under the plow could meet some of the rising demand for food, but the opportunities for cropland expansion are limited. About 87 percent of potential cropland is in developing countries, mainly Latin America and Sub-Saharan Africa. The productivity of this land is expected to be lower than the existing stock of cropland. In addition, conversion could destroy forests and rangelands that have valuable ecological functions.

In the highly populated areas of Asia, where demand is most intense, almost all of the suitable land is already under cultivation. Western Europe, the United States, and Oceania have actually retired about 41 million hectares from production since 1966. During 1986–96, West Asia was the only region where agricultural land area expanded by more than 1 percent annually.

IFPRI projects that by 2020 an additional 20 million hectares of cereal cropland will be planted in Sub-Saharan Africa, 8 million more hectares in Latin America, but only another 13 million hectares in the rest of the developing world. This would be an increase of about 8 percent over the current 480 million hectares of cereal crop area in the developing world. According to IFPRI, the primary constraint in the expansion of crop area is that cereal prices are not expected to rise, which in many cases makes cropland expansion unprofitable.

Irrigated Area

Seventeen percent of total cultivated land is irrigated cropland that currently produces nearly 40 percent of the world's food. China and India contain 39 percent of the total global irrigated area, while less than 4 percent of cropland in Sub-Saharan Africa is irrigated.

New irrigation development has slowed since the 1970s due to escalating construction costs, low and declining prices of staple cereals, declining quality of land available for new irrigation, and increasing concerns over the environmental and social impacts of large-scale irrigation projects. According to the FAO, the annual growth rate in global irrigated area declined from 2.2 percent during 1967–82 to 1.5 percent during 1982–95.

IFPRI expects the irrigated cereal area to increase from the 1997 total of 218 million hectares to 248 million hectares by 2020—with an additional 1 million hectares in developed countries and 29 million hectares in developing ones.

The World Water Council notes that the expansion of irrigated agriculture poses a troubling dilemma. A 30-percent increase in irrigated area would likely lead to severe water shortages and serious risks of deteriorating ecosystems, while a reduction in the growth of irrigated area could cause considerable food shortages and rising food prices. Given these two unattractive alternatives, the Council's *World Water Vision* emphasizes improving the productivity of water use in agriculture.

Fertilizer Use

Applications of inorganic fertilizers containing nitrogen, phosphorus, and potassium have long been a staple of agricultural success. Insufficient replenishment of soil can lead to long-term nutrient depletion that can exhaust fertility, whereas excessive or poorly timed fertilizer use can lead to nutrient runoff into surface waters and cause serious environmental damage.

Fertilizer use varies widely around the world. In the heavy-use areas—including Europe, the United States, Japan, and possibly China—applying additional nutrients is not likely to have much effect on production. But in areas such as India and Latin America, additional fertilizer could help boost production.

Farm Size

In many parts of the developing world, population growth is having a dual effect, both increasing food demand and shrinking farms to untenably small sizes. In Bangladesh, for example, average farm size has already fallen below 1 hectare. Bangladesh's tradition of bequeathing land in fixed proportions to all male and female heirs promises to further reduce average farm size. The Worldwatch Institute reports that India may now have 90 million or more families with farms of less than 2 hectares.

OVERCOMING THE BARRIERS

Many of the key components of a more sustainable food production system depend on the policy environment.

Subsidies

It is estimated that governments spend more than $700 billion a year to subsidize environmentally unsound practices in the use of agriculture, water, energy, and transport. In developed nations, about $360 billion is spent each year to subsidize farm income and farm production.

Some $33 billion is spent each year to subsidize water. In India, for example, the direct subsidy to surface water irrigation is estimated at $800 million a year, while the indirect support—through subsidized electricity used to pump groundwater—is about $4 billion.

By keeping prices low, such subsidies reduce incentives for farmers to invest in efficiency. Similarly, energy subsidies in many countries have artificially reduced the cost of groundwater pumping and encouraged farmers to overuse this resource.

Further, low-priced water does not provide sufficient revenues to operate and maintain water systems, to invest in new infrastructure, or to research new technologies. Low water prices also have slowed the introduction of water-saving technology.

Land Tenure and Water Rights

Many farmers lack secure tenure to their land, which greatly increases the risk of investing in land and water conservation or other improvements. Land tenure is a particularly important issue for women farmers. In some developing countries, as many as one-third of rural households are headed by women, yet less than 2 percent of all land is owned by women. Partly as a consequence, women have less access to credit and inputs, and receive only 5 percent of agricultural extension services worldwide.

Rights to water use are usually closely connected to land rights. In irrigated areas, rights to irrigation water are generally distributed among those who have land in the command area. Where land is unequally distributed, water is also often unequally distributed.

Obstacles to New Technologies and Management Practices

In Sub-Saharan Africa, the lack of access to affordable technologies for small farmers has slowed the spread of irrigation. In many countries in the region, small-scale farmers account for 80 percent or more of the farm population.

In addition to the land tenure and gender issues mentioned above, other obstacles aggravating this problem include:

- High costs of equipment, often 220 times more expensive than in Asia.
- Poor transportation and marketing facilities, which reduce the profitability of agricultural investments.

Lack of an Integrated Approach

Land and water management institutions tend to be centralized, technically oriented agencies that support one or two specific aspects of management, such as water supply utilities or irrigation agencies.

Although it often leads to short-term economic gains, the single-sector approach to land and water management can result in long-term environmental degradation because it fails to account for the complex linkages among various components of the ecosystem. It typically seeks to maximize the benefits of one sector, such as irrigated agriculture, without considering effects on other sectors. In addition, this approach tends to rely heavily on technical and engineering solutions, making little or no attempt to address related policy and institutional issues.

Development activities in the Senegal River valley highlight many of the unintended environmental and social impacts of the single-sector approach. Two dams were constructed on the Senegal River in the 1970s to support intensive rice production, electricity generation, and year-round navigation. Environmental and social considerations were not fully addressed in the design of the projects. As a result, about 50 percent of the irrigation fields have been lost to soil salinization, dams and dikes have reduced traditional grazing lands from 80,000 to 4,000 hectares, water pollution from pesticides and other agrochemicals is significant, and fish production in the river and estuary has dropped by 90 percent.

PROMISING APPROACHES

Despite the barriers described above, there are many encouraging examples of initiatives to promote environmentally sound food production.

Improving Water-use Efficiency

A critical need in the next few decades is to improve the efficiency of water use, especially for agriculture. *World Water Vision* lists a range of technical and management options to improve productivity, including:

- Developing new crop varieties with higher yields per unit of water—for example, crops with comparable yields but shorter growth periods
- Switching to crops that consume less water or use water more efficiently
- Improving soil management, fertilization, and pest and weed control
- Improving the reliability of water supplies at critical crop growth periods; this would encourage farmers to invest more in other inputs and lead to higher output per unit of water
- Promoting deficit irrigation, which can increase productivity per unit of water by providing less-than-full irrigation requirements; and supplemental irrigation, which uses limited irrigation at critical periods to supplement rainfall. In the Syrian Arab Republic, for example, researchers have demonstrated that reducing full irrigation by 50 percent results in a yield loss of only 10 percent.

A broad range of irrigation technologies now available can increase water productivity. For example, drip irrigation, which uses a network of perforated plastic tubes that deliver water directly to the roots

of plants, can cut water use by 30–70 percent and increase crop yields by 20–90 percent.

Another efficient sprinkler system known as low-energy precision application has drop tubes extending vertically from the sprinkler arm. These tubes deliver water much closer to the plants, reducing evaporation losses. Used in combination with time-controlled surge valves, which distribute water more uniformly down furrows, these systems can produce water savings of 25–37 percent compared with conventional furrow irrigation.

There are also a variety of management techniques that can improve irrigation efficiency. These include improving irrigation timing, improving canal operations for more efficient deliveries, applying water only at crucial periods, using water-conserving tillage and field preparation methods, improving canal maintenance, and recycling drainage and tail water. In the Arys-Turkestan region of south Kazakhstan, for example, the International Center for Agricultural Research in the Dry Areas (ICARDA) is experimenting with alternative furrow irrigation, which supplies every other furrow with water. Combined with the use of shallow groundwater, this system uses about half as much water as traditional irrigation and loses two-thirds less in runoff, resulting in substantial water savings and enhanced productivity.

In addition, there are a wide array of small-scale irrigation strategies for areas with scarce water supplies. For example, check dams built across gullies can trap large amounts of runoff, which can be channeled to fields or stored for later use.

Above all, reducing water subsidies will help promote more efficient water use (see Chapter 1). The *World Water Vision* recommends that consumers be charged the full cost of providing water services, including the cost of obtaining the water and of collecting, treating, and disposing of wastewater. Full cost pricing will make water suppliers accountable to users, reduce water withdrawals from ecosystems, and provide the revenue needed to cover operation and maintenance costs. Such policies must be accompanied by targeted, transparent subsidies to low-income communities and individuals.

Conserving Soil Resources

A wide variety of strategies are available to rebuild and conserve soil resources. In less-favored areas in the East African highlands, for example, inexpensive ways to improve nutrient management include improved fallows, biomass transfer, crop residue management, manure management, and composting. In steeply sloping areas prone to erosion, solutions include bench-terracing, natural vegetative strips, stone walls, and perennial tree crop systems. In the Southeast Asian uplands, contour hedgerows are effective in controlling soil erosion. Agroforestry, which combines annual and perennial plants, can help maintain soil fertility because perennial crops help recycle nutrients and reduce erosion.

Conservation agriculture is gaining acceptance around the world. Recent studies estimate that conservation agriculture is practiced on about 58 million hectares of farmland, mainly in North and South America, but also in Southern Africa and South Asia.

Under this approach, farmers leave crop residues in the ground as soil cover. Rather than tilling the soil at the start of the next cropping season, they use special equipment to drill the seeds directly into the soil. The surface cover reduces mineralization, erosion, and water loss. In addition, it inhibits the germination of weeds, protects soil microorganisms, and helps build up organic matter.

Conservation agriculture does not preclude the use of chemical inputs. Herbicides are an important component, particularly in the transition phase until a new balance in the weed population is achieved. Conservation agriculture generally uses fewer chemical inputs than conventional farmers. Over the years, the use of inputs tends to decline. In the long run, disease problems do not increase if sound crop rotations are adopted. The system can be used to grow grains, pulses, sugar cane, potatoes, beets, and cassava.

Using New Information Technologies

Advances in information technology, such as computer simulation models that are built on digital databases and integrate satellite imagery and geographic information systems, are increasingly helping to define problems, evaluate risk, and design technologies for improved food production.

The International Water Management Institute (IWMI) has integrated agricultural weather data from 56,000 weather stations around the world for the period 1961 to 1990. Available on CD-ROM and the Internet, the *World Water and Climate Atlas* can be used to better match crops and crop varieties to local climate conditions.

At the national level, ICARDA has used remote sensing data to develop a land-use map of the Syrian Arab Republic. The map clearly shows degradation of vegetation in the coastal mountains, evidence that perennial grasses have almost entirely disappeared, signs of wind erosion in the arid interior, and the results of water erosion around the Euphrates Valley.

A new technology called "diffused reflectance spectrometry" helps measure soil quality in the field quickly and inexpensively. Using this technology, scientists can process between 350 and 500 soil samples a day under laboratory conditions, which gives them a new way to look at soil degradation and helps provide more timely mitigation advice.

Working with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), national research teams in Africa and Asia are field-testing an Agricultural Production Systems Simulator, which weighs tradeoffs in given scenarios for the production of various crops. In Tamil Nadu, India, for example, the system helped convince farmers to try alternative sowing dates and more efficient water management for groundnut production.

Increasing Community Participation

More than 25 governments are now in the process of transferring responsibility for irrigation systems to local farmers' groups or other private organizations. In Mexico, for example, management of more than 85 percent of the nation's publicly irrigated land has been turned over to farmers' associations. Water fees have been increased to cover costs, and the irrigation districts are about 80 percent financially self-sufficient.

Water users' associations are an effective way to improve efficiency, productivity, accountability, and responsiveness to farmers. They give users the authority to operate and maintain water systems, collect fees, hire professionals, and manage water rights. In the Liuduzhai Project in the Yangtze Basin in China, for example, the World Bank found that water users' associations led to greater transparency, lower costs, and better and more services to the poor.

Transferring Affordable Technologies

Many low-cost irrigation methods for farmers can dramatically improve productivity. For example, human-operated treadle pumps, which are operated by pedaling up and down on two long poles to lift groundwater to the surface, can irrigate about one-fifth of a hectare. One pump costs about $35, including installation of the tubewell, but farmers can usually get their investment back in less than a year. In Bangladesh, farmers have purchased more than 1.2 million treadle pumps, which are operating on about 250,000 hectares. International Development Enterprises, a nonprofit organization that is marketing the pumps, estimates that the total market could be 10 million pumps, including 6 million in India and 3 million in Bangladesh.

In Kenya, the Asian treadle pump has been reconfigured into a lighter, portable device called a pedal pump. Approtech, a local NGO, is selling the pump for about $70 in Kenyan towns and villages.

EMPHASIZING ECOSYSTEMS

Many initiatives that promote sustainable use of land and water resources for food production are taking place at the river basin or ecosystem level. A critical goal is to meet the needs of both upstream and downstream users.

In Cameroon, for example, a dam constructed in 1978 for rice irrigation greatly restricted the seasonal flooding of the downstream floodplain along the Logone River. A decade later, IUCN began a project to rehabilitate the floodplain, including the 171,000-hectare Waza Park. Pilot water releases through newly constructed openings in the main river levee have restored about 60 percent of the affected floodplain. This has improved the environment and living conditions for people in the lower catchment near the floodplain without affecting the rice project.

In Lesotho, the Lesotho Highlands Water Project is an interbasin transfer project that would export water from the Senqu/Orange River in Lesotho to South Africa. As part of the project, the World Bank financed an environmental flow assessment that studied the complete river ecosystem. Based on the findings of the assessment, the design of the project's Mohale Dam was changed to a multiple outlet structure. This will allow releases of varying quantity and quality, including occasional flood flows, to meet the requirements of downstream ecosystems.

Mexico's 1992 National Water Law authorizes the creation of river basin councils to provide a forum for identifying and evaluating problems and needs; developing consensus between the various government entities, water users, and other interested parties; recommending actions and obtaining commitments to implement them; and ensuring continuing commitment and compliance with agreed-upon initiatives. The councils are responsible for making the planning process dynamic, participatory, and results-oriented.

The new South African and Brazilian water laws are also important examples of an integrated ecosystem approach (see Chapter 1), as is the Murray-Darling Basin Initiative in Australia, which is described later in this chapter.

Local Adaptation Strategies

There are several encouraging examples of effective local responses to drought conditions in developing countries. In Burkina Faso, the Mossi plateau receives only about 700 millimeters of rainfall per year, which varies in extent, duration, and intensity. Since 1976, rainfall levels have been falling, leading to migration, food shortages, and land degradation.

At the village level, self-help groups known collectively as the Naam Movement developed a number of strategies to manage water shortages. As one response, they built *diguettes*, or stone lines constructed along contours that were designed to temporarily restrict water movement across fields, increase infiltration time, and catch organic debris. The lines, which are often reinforced with vetiver grass, are effective at increasing agricultural production, reducing soil erosion, reclaiming degraded fields, and replenishing aquifers. They were built throughout the Mossi plateau and significantly increased food and water security.

Many other traditional water harvesting technologies were also spread through Naam groups, including *zai*, which are small pits dug in the field with a little compost to trap water; *demi-lunes*, or half-moons, which were constructed out of earth on the downside of a contour and used to trap water; and erosion bunds, which were dug on contours with a depth of about half a meter to increase water availability for crops.

In the Machakos district southeast of Nairobi in Kenya, the Akamba people have managed to develop successful hillside farming systems in semiarid conditions. At the turn of the twentieth century, the new British colonial government imposed boundaries on the Akamba and other native people in Kenya. The Akamba retained most of their traditional lands, but the new boundaries precluded movement to new fields during periods of drought, population growth, or declining soil fertility. From 1900 to 1930, the population more than doubled, soils became exhausted, and crop yields fell. During the mid-1930s, droughts occurred during six of the eight semiannual growing seasons. When the rains did come, the parched and deforested hillsides suffered severe erosion.

The colonial government began investing in land conservation projects in the 1930s, requiring the Akamba in compulsory work gangs to construct narrow-based terraces, or contour ditches. These efforts lost favor with Akamba farmers, but later Akamba innovations in the 1950s used a variation of this idea called *fanya juu* terraces. These terraces are constructed by digging a trench along the contour of a slope and throwing the excavated soil uphill to form a gently sloping field with an earth embankment that collects rainfall and slows runoff. Though labor-intensive, these bench terraces soon become stable and require only periodic maintenance.

BOX 2.2

A NEW ERA FOR RICE

Scientists from The Consultative Group on International Agricultural Research's (CGIAR) West Africa Rice Development Association (WARDA) have developed new upland rice varieties—NERICA, or New Rice for Africa—that could have a significant impact on rice production in Africa's upland areas.

Using a technique called embryo rescue, researchers have developed new varieties that combine the high productivity traits of Asian varieties with the ability of African varieties to smother weeds, tolerate drought and problem soils, and resist pests.

Weeding—performed mostly by women and children—accounts for 30–40 percent of the labor invested in a West Africa rice crop. The new varieties have wide, droopy leaves that smother weeds, which substantially reduces weeding and allows farmers to work a parcel of land longer, thus reducing the need to clear new land.

NERICA's grain heads are held higher than most varieties, which makes harvesting easier. In addition, the new rices grow better than other rices on infertile, acidic soils, which make up 70 percent of West Africa's upland rice area. The new rices have about 2 percent more bodybuilding protein than either their African or Asian parents. They mature in 90–100 days, which is some 30–50 days earlier than other varieties.

WARDA estimated that if farmers planted nearly 90,000 hectares of these rices in Guinea, they would save the nation $13 million in import costs. By 2004, adoption of NERICAs on 25 percent of the land now planted in other rices in Guinea, Côte d'Ivoire, and Sierra Leone would return an extra $20 million to farmers per year.

As a result of the success of NERICAs, the NERICA Consortium for Food Security in Sub-Saharan Africa was formed in April 2001. This consortium is made up of networking institutions and stakeholders, national agricultural research and extension systems, donors, NGOs, farmers' organizations, and the private sector. The consortium intends to disseminate the NERICA rice varieties widely and rapidly to poor farmers in Sub-Saharan Africa.

Source: CGIAR.

During the 1950s, more than 40,000 ectares were terraced in Machakos, partly pushed / the government's decision to allow Akamba far ers to grow coffee for export for the first time. C fee can only be planted on steep slopes if they are erraced.

In 1956, the new and mainly African caffed community development service replaced ne compulsory work gangs with the *mwethyas*, o raditional work party, whose members chose e h other and their own leaders. For the first time i Akamba history, women participated in the grou and were elected to leadership positions. Withe t any government aid, more terraces were buil from 1960 to 1980 than were built during the 195 . In the early 1980s, some 8,500 kilometers of ter es were built annually. A 1998–99 aerial survey su ests that about 60 percent of the fields in Mac akos are terraced, and many farmers also are usi other conservation measures.

Machakos also was helped by expan g market opportunities, not only for coffee bu or other export crops such as French beans, c us, and mangoes. In addition, an estimated 41 pe ent of rural income came from nonfarm business nd wages, which was often invested in farm im ovements such as terraces and water storage tanks. Another important factor was a shift from central government decisionmaking about ecosystem issues to greater district-level participation.

AN ACTION AGENDA FOR LAND, WATER, AND FOOD PRODUCTION

Successfully promoting environmentally sound food production requires action in five key areas: mainstreaming integrated approaches to land and water management; strengthening the enabling environment; adopting good management practices and environmentally sound technologies; expanding and accelerating capacity development; and strengthening partnerships.

This action agenda is drawn from the March 2002 GEF Roundtable on Land, Water, and Food Security, including both the background paper and the summary of the meeting. The roundtable was co-chaired by H.E. Dr. S.W. Kazibwe, vice president of the Republic of Uganda, and Dr. M. S. Swaminathan, chairman of the M.S. Swaminathan Research Foundation.

Mainstreaming Integrated Approaches to Land and Water Management

Integrated land and water management approaches provide a comprehensive framework for countries to manage land and water resources in a way that recognizes political and social factors as well as the need to protect the integrity and function of ecological systems.

Resource owners, managers, upstream and downstream users, and other stakeholders should participate in resource allocation and management decisions, taking into account ecological, economic, and social factors. Such an approach minimizes conflicts over resource allocation and management. It also facilitates the integration of technical and engineering solutions with needed policy and institutional reforms.

Traditional or indigenous systems of natural resources management are based on the same principles of integration.

Several countries have established river basin management programs in an attempt to use integrated approaches. For example, the Murray-Darling Basin (MDB) Initiative in Australia, which was started in 1987, has:

- Introduced improved land management techniques to minimize the amount of irrigation water being added to the water table. New crops and more efficient irrigation technology will help support more sustainable land use.
- Constructed engineering works to intercept highly saline groundwater and pump it to suitable disposal sites before it flows into the main river system.

- Adopted new operating rules to reduce evaporation losses from reservoirs.

The MDB also recognizes the importance of wetlands in enhancing river water quality. The project is working to enhance floodplain wetlands ecosystems. In addition, constructed wetlands are being specifically designed to reduce nutrient loads from farm runoff, sewage treatment, industrial plants, and urban runoff.

Throughout Australia, farmers and other rural industries are working with government and other rural communities to solve rural problems. More than 2,000 voluntary landcare community groups are currently working to develop more sustainable systems of land and water use within catchments.

Strengthening the Enabling Environment

To succeed, integrated land and water management approaches must be supported by appropriate policies, regulations, and institutional arrangements. Countries should, therefore, give priority to strengthening these arrangements in ways that facilitate wider adoption of integrated and cross-sectoral approaches to land and water management.

Subsidies and pricing of inputs such as land, water, seeds, and agrochemicals are major policy issues. There is ample evidence that underpricing of natural resources and subsidies for agricultural inputs can lead to overexploitation of those resources and degradation of the environment (see Chapter 1).

Full-cost pricing of water is desirable in the long run, but there are many alternatives that could be politically easier to initiate now. Under a tiered pricing scheme, for example, farmers would be charged the customary rate for perhaps 80 percent of their water use, a much higher rate for the next 10 percent, and the full marginal cost for the last 10 percent.

Another major policy issue is the security of land tenure and water rights. As described earlier, resource users are less willing to make investments to protect the environment when they have no ownership or when access is restricted. In the absence of such security, they focus on maximizing

short-term benefits, often to the detriment of the environment. Policies on subsidies, pricing, tenure security, and other key issues should promote equitable and reliable resource access, efficient resource use, and environmental protection.

Adopting Good Management Practices and Environmentally Sound Technologies

An important priority is to facilitate the development and wider adoption of good management practices and technologies, such as low or zero tillage and farming systems that use drought-resistant or low-water-consuming crop varieties as well as more water-efficient irrigation systems. The development and adoption of better management practices and technologies could be facilitated by collaboration among public and private international agricultural research centers, national research centers, policymakers, NGOs, and local resource users.

"Poverty is the most critical threat to sustainable development. The gap between the poor and the rich is widening by the day."

Mohammed Valli Moosa
Minister of Environmental Affairs and Tourism, South Africa

It is noteworthy, for example, that in Bangladesh the treadle pump mentioned earlier has spread entirely through activities of the private sector, with no government subsidies. A significant support system in Bangladesh—70 manufacturers, 830 dealers, and 2,500 installers—has also helped create jobs and raise incomes.

The 16 centers supported by CGIAR are playing a valuable role in facilitating the adoption of more sustainable practices. For example, the International Institute of Tropical Agriculture (IITA) is using integrated pest management strategies in many projects in Sub-Saharan Africa. In dry savannah and Sahel sites, *striga* (a parasitic weed), stemborers, and poor soil fertility are badly damaging cereal-based cropping systems. In Kenya, farmers are fighting *striga* and stemborers by combining a *striga*-tolerant maize variety developed by the Kenya Agricultural Research Institute with the fodder legume *desmodium* in an intercropping and habitat management system that includes the use of Napier grass. More than 100 farmers in a pilot project have experienced a 20-percent increase in maize yields, and have a new market opportunity for the sale of *desmodium* and Napier grass.

Expanding and Accelerating Capacity Development

The best information on the enabling environment and on resource management practices and technologies will not result in wider adoption of integrated land and water management approaches—unless there are people with the skills needed to plan and implement such programs. Governments need to expand and accelerate capacity development activities through in-country formal and informal educational programs, advanced training, and staff exchanges among developing countries and between developed and developing nations.

Capacity development programs should be tailored to the needs of specific stakeholder groups involved in a particular resource management issue, and should draw on the expertise and experience of local and international organizations. These programs can help raise environmental awareness, improve technical skills, and provide facilities and equipment to support integrated natural resource management activities.

There are four priority groups for capacity development: national and local economic and develop-

ment planners; resource owners such as government entities, local communities, individuals, and private firms; resource managers such as government and private-sector employees and local communities; and resource users such as government agencies, local communities, and the private sector.

Strengthening Partnerships

One of the positive lessons from the Green Revolution is that partnerships involving a broad range of government and nongovernmental stakeholders, including government and private research institutions, bilateral and multilateral development agencies, and foundations, can play a major role in addressing the issue of food insecurity. Box 2.2 describes a successful example of how such a partnership developed new rice varieties for the African uplands.

Countries need to strengthen existing partnerships or create new ones to provide an effective mechanism to achieve food and environmental security through integrated land and water management. Partnership arrangements can help mobilize funds from a variety of sources, including local and national budgets, bilateral development cooperation agreements, and country assistance programs of multilateral agencies and foundations. Improved coordination would help to avoid duplication of effort as well as piecemeal approaches to addressing food and environmental security issues.

Partnerships can provide legitimacy and technical resources to a program, which in turn can improve opportunities to leverage in-country policies and institutional reforms in support of integrated land and water management. Partnerships can also help to strengthen information exchanges—for example, by establishing clearinghouses or providing technical assistance. Information should be accessible not just to scientists but also to policymakers, resource managers, and resource users.

Partnerships can also play a valuable role in supporting research on analytical tools, management models, farming systems, and environmentally sound technologies. For example, bringing together the expertise of international and national research centers and the knowledge and experience of local policymakers and farmer associations can have a major impact on the pace, quality, and relevance of research. Priority should be given to improving the infrastructure and capacity of national research centers in developing countries—to make them effective partners in international efforts to address food and environmental security.

LAND, WATER, AND FOOD PRODUCTION TARGETS FOR 2015

- Reduce the number of people suffering from hunger by half between 1990 and 2015, with a special focus on small-scale farmers who produce a major share of food in developing countries.
- Achieve a 30-percent gain in the efficient use of irrigation water by 2015, with no net increase in water diversion over that used in 2000.

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FORESTS AND BIODIVERSITY: SAVING VALUABLE ASSETS 3

Forests are repositories of the earth's natural heritage. They provide a range of goods and services—from protecting watersheds, to providing habitats for biodiversity, to storing carbon—that are intrinsically linked to humanity's long-term well-being (Box 3.1). But as the health of a forest deteriorates, all of its goods and services are threatened. The Food and Agriculture Organization of the United Nations (FAO) currently estimates that about 15.2 million hectares of forest are lost every year in the tropics, largely as a result of rapid, planned, or large-scale conversion to other land uses, mainly agriculture.

Even as deforestation continues in tropical zones, a host of new ideas and initiatives provide hope that the world is moving toward protecting and sustainably managing the global forest estate. These developments are particularly important:

- Increasing devolution of the rights and management of forests to indigenous and other local communities
- Increasing influence of global markets on forest management, including the growing capacity of forest plantations to help meet the world's wood demands
- Emerging demand for the environmental services that forests provide, from water purification to ecotourism
- Shifting from an excessive focus on establishing new protected areas to strategies that emphasize integrated landscape and mosaic approaches

BOX 3.1

FORESTS AS HABITATS

Forests are home to about two-thirds of known terrestrial species and have the highest species diversity and endemism of any ecosystem. Of the 136 ecologically distinct regions identified as outstanding examples of biodiversity, two-thirds are located in forest regions.

Forest biodiversity provides an invaluable array of goods and services. The diverse species found only in forest habitats are sources of new pharmaceuticals, genetic resources, and nontimber forest products such as resins, fruits, vines, mushrooms, and livestock fodder.

In addition, the highest number of threatened species live in forests. These include many forest-dwelling large mammals, half of the large primates, and nearly 9 percent of all known tree species. Of an estimated 100,000 species of trees, the World Conservation Monitoring Centre estimates that more than 8,700 are now threatened globally. More than 70 percent of 596 key areas providing habitat for threatened bird species are in forests.

If recent rates of tropical forest loss continue for the next 25 years, UNEP's Global Biodiversity Assessment estimates that the number of species in forests would be reduced by about 4–8 percent.

Sources: World Resources Institute, UNDP, UNEP, and World Bank, 2000.

- Widening recognition of the role of forests as carbon sinks and as a common biome for addressing synergies between the Convention on Biological Diversity (CBD), the U.N. Convention to Combat Desertification (UNCCD), and the U.N. Framework Convention on Climate Change (UNFCCC), among others
- Growing acceptance of governance, transparency, and accountability, including the growing role of independent certification, as indicators of good resource management
- Increasing awareness of emerging threats, including the risks posed by climate change and non-native invasive species.

Two major challenges remain. First, in most developing countries the conservation of natural forests is a relatively small part of the much bigger picture of poverty, slow economic growth, and weak institutions. Improved conservation and management of forests depends on balanced economic development in poor countries that includes improved governance, more effective market mechanisms, secure tenure and access rights, strengthened institutional capacity, and poverty alleviation strategies that recognize the importance of forests.

A second long-term challenge is to incorporate the value of forest services, and most important, the contributions of forests to the livelihoods of the poor into conventional economics. Several payment mechanisms for environmental services have been tested, but payments have not yet become a major factor in achieving forest conservation. As a climate change mitigation measure, payments for the carbon storage value of forests could be a potentially significant new development in the coming decades.

WEIGHING GAINS AND LOSSES

FAO estimates that there are about 3.87 billion hectares of forest. About 47 percent of the world's forests are in the tropics, 9 percent in the subtropics,

TABLE 3.1

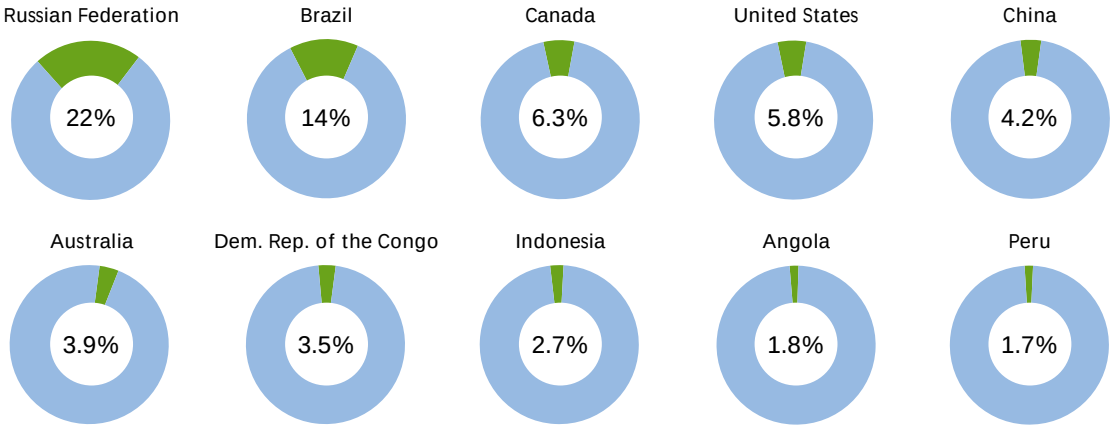
Forest Area by Region, 2000

Region	Land area (million ha)	Total forest (natural forests and forest plantations) Area (million ha)	Percentage of land area	Natural forest (million ha)	Forest plantation (million ha)
Africa	2,978	650	22	642	8
Asia	3,085	548	18	432	116
Europe	2,260	1,039	46	1,007	32
North and Central America	2,137	549	26	532	18
Oceania	849	198	23	194	3
South America	1,755	886	51	875	10
World total	**13,064**	**3,869**	**30**	**3,682**	**187**

Source: FAO, *State of the World's Forests 2001.*

FIGURE 3.1

Countries with the Largest Shares of Forests, 2000



Source: FAO, *Global Forest Resources Assessment 2000.*

11 percent in the temperate zone, and 33 percent in the boreal zone (Table 3.1).

Two-thirds of the world's forests are located in only 10 countries: the Russian Federation, Brazil, Canada, the United States, China, Australia, the Democratic Republic of the Congo, Indonesia, Angola, and Peru (Table 3.1). By region, Europe (including the Russian Federation) and South America have the largest percentage of the world's forests (27 and 23 percent, respectively), while Oceania has the least (5 percent). About half of the land area of South America and Europe is forested, but only one-sixth of Asia's land is forested (Figure 3.1).

TABLE 3.2

Annual Change in Forest Area, 1990-2000 (million ha)

DOMAIN	NATURAL FOREST					FOREST PLANTATIONS			TOTAL FOREST
	Loss			Gain	Net change	Gain		Net change	Net change
	Deforestation	Conversion to forest plantations	Total loss	Natural expansion of forest		Conversion from natural forest	Afforest-ation		
Tropical areas	-14.2	-1.0	-15.2	+1.0	-14.2	+1.0	+0.9	+1.9	-12.3
Non-tropical areas	-0.4	-0.5	-0.9	+2.6	+1.7	+0.5	+0.7	+1.2	+2.9
World	-14.6	-1.5	-16.1	+3.6	-12.5	+1.5	+1.6	+3.1	-9.4

Source: FAO, *State of the World's Forests 2001.*

Worldwide, an estimated 16.1 million hectares of natural forest were lost annually during the 1990s, including 14.6 million hectares through deforestation and 1.5 million hectares through conversion to forest plantations. Of the 15.2 million hectares lost in the tropics each year, 14.2 million hectares were converted to other land uses, and 1 million hectares were converted to forest plantations. Against the gross annual loss of 16.1 million hectares of natural forests worldwide, there was a gain of 3.6 million hectares as a result of natural forest expansion, leaving a balance of –12.5 million hectares as the annual net change of natural forest (Table 3.2).

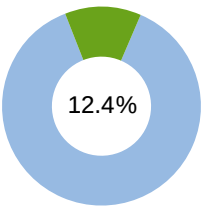
The underlying causes of forest loss vary among regions. In Africa, the expansion of subsistence agriculture is the principal cause; in Latin America, the main causes are large-scale cattle ranching, clearance for government-sponsored settlements, and hydroelectric reservoirs; and in Asia, subsistence agriculture and economic development schemes account for the loss.

The condition of global forests is not well documented and varies considerably from place to place. According to FAO, the principal direct causes of forest degradation include insect pests and diseases; fire; overharvesting of industrial wood, fuelwood, and other forest products; mismanagement of production forests, including poor harvesting practices; overgrazing; air pollution; and extreme climatic events such as storms. Habitat degradation caused by these factors and the overharvesting of wildlife are major contributors to the local depletion of forest-based wildlife populations. Underlying causes include poverty, population growth, markets and trade in forest products, and macroeconomic policies.

About 479 million hectares (12.4 percent of the world's forest area) are in protected areas, according to FAO. It estimates that about 20 percent of all forests in North and South America are protected. In contrast, only about 5 percent of Europe's forests are protected, though this relatively low figure is mainly due to the fact that it includes the largely unprotected Siberian forest areas in the Russian Federation (Figure 3.2).

FIGURE 3.2

Forests in Protected Areas, 2000



Total Forest Area in 2000: 3,869 million ha

Proportion of Forests in Protected Areas: 12.4%

Source: FAO, *Global Forest Resources Assessment 2000.*

By region, FAO found that:

- The bulk of tropical forests in the African Great Lakes region are unprotected.
- In Asia, most closed forests in Papua New Guinea and Indonesia are unprotected and threatened by logging, agricultural clearing, or mining.
- Europe's last few large blocks of forest area in Sweden and Finland are well protected.
- Russia's boreal forests are still largely intact, but the percentage of protected area is very low.

These estimates are based on a new global map of protected forest areas developed for FAO in collaboration with the U.N. Environment Programme's World Conservation Monitoring Centre (UNEP-WCMC). In addition, industrial countries reported on protected forest areas in response to questionnaires prepared by the U.N. Economic Commission for Europe and FAO. Protected areas are classified according to the categories established by the IUCN. The raw data in the UNEP-WCMC database includes all land under protected management status, not just forestland. The UNEP-WCMC global protected areas map was overlaid with a global forest cover map to develop an updated global protected forests map.

FAO noted that there are continuing difficulties in obtaining a consistent approach for comparing forest areas that countries report as protected, so these global statistics may not be representative of the actual protection afforded to forests in different countries. Further, many parks may only be "paper" parks. In China, for example, by 1997 only two-thirds of all nature reserves actually had staff and budgets for management and protection.

CHANGING LANDSCAPES

Since the 1992 Rio Earth Summit, a great deal has changed in the forest sector, providing opportunities for expanded conservation and sustainable use of forests and biodiversity in support of poverty alleviation. For example:

- In the environmental area, important developments include increased recognition of major environmental threats such as invasive species and climate change, and the growing interest in wider approaches to forest and biodiversity protection.
- In the economic area, key trends include market changes such as the increased role of forest plantations, the greater influence of global markets on forest management, and the emerging interest in systems of payment for ecological services.
- In the social and political areas, major changes include a dramatic increase in indigenous and other community forest ownership and management, greater attention to governance, and the growing role of independent certification.

New Environmental Perspectives

Emerging threats. Partly as a result of the rise in global trade, the problem of non-native species invasions has increased dramatically. Between 1965 and 1998, imports of agricultural products and industrial raw materials increased ninefold. In the process, many non-native species were unintentionally introduced as contaminants in the movement of goods.

Non-native invasive species in forests can create unstable ecosystems, increase the negative impacts of fire, impede or stop vital species interactions, promote the extinction of species that are symbiotic with native forest species, and alter key ecosystem functions (Box 3.2).

As consensus builds that global climate change is under way, there is a heightened understanding of the implications for forests. Studies show that the greater frequency of extreme climatic events affects forests significantly. High-intensity windstorms and floods become "gap-forming" processes that favor introduced species, which tend to be reproduced

more rapidly than native species. Riparian forests destroyed by floods are being continually replaced with non-native plant species. Climate change also modifies local climatic regimes, leading to species and ecosystem extinction where conditions become unfavorable for locally occurring native species.

Protected areas and integrated approaches. There is clear and unequivocal agreement that protected areas remain critical centers for biodiversity conservation. Protected areas constitute important storehouses of genetic, species, habitat, and ecosys-

BOX 3.2

UPSETTING NATURE'S BALANCE

Forests are increasingly threatened by the introduction of non-native species, now cited as the second cause of biodiversity loss after deforestation. Although only about 1 in 1,000 non-native species becomes invasive, those that thrive in new environments can trigger serious economic and environmental harm. Estimates of damages caused by invasive species each year range from $55 billion to $248 billion.

There are many documented cases of the negative long-term effects of non-native invasive species on ecosystems. Native forest species are often displaced, creating imbalanced ecosystems or inducing the collapse of vital species interactions. For example, the New Zealand kaka (forest parrot) and other nectivorous species must compete for honeydew with the invasive common wasp introduced in the 1970s. Deprived of their natural food source, weakened kakas face greater exposure to predation. Introduced species may also intensify the impacts of fire by providing a more flammable source of fuel. In northern Australia, the introduction of West African gamba grass added several tons per hectare to the fuel load of naturally occurring bushfires.

Environmental factors such as climate change and acid rain also have implications for non-native invasions. Introduced species may enjoy a new competitive advantage over native flora and fauna in adapting to changing climatic conditions. Riparian fig forests in South Africa were devastated by a series of cyclones attributed to climate change; in their wake, non-native plant invasions have occurred on a massive scale. Persistent atmospheric pollution, in the form of acid rain, for example, also increases the mortality rates of native species—to the advantage of hardier invasive exotic organisms.

Several countries, including Australia, New Zealand, South Africa, and the United States, have developed control strategies that can serve as models. The Asian long-horned beetle, brought into the United States in the late 1990s on wood-packing material carrying Chinese imports, has a highly destructive capacity if released in forested or suburban areas. Through aggressive survey and tree removal programs, the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) succeeded in restricting beetle infestations to New York and Chicago.

Biological controls also can be effective. South Africa's unique fynbos vegetation was under severe threat from invasive Australian acacia trees. The situation was brought under control by the release in the 1980s and 1990s of insects that halted acacia seed production. The Convention on Biodiversity, the International Plant Protection Convention, and other global agreements have helped increase responsiveness to the problem.

Source: Macdonald and van Wilgen.

tem diversity and are supported by a wide range of stakeholders. However, there is also a strong emerging consensus that—for pragmatic, scientific, and technical reasons—conservation efforts must extend beyond protected areas. There are limits to a country's set-aside areas. Even the most ambitious supporters of biodiversity protection recognize that most countries will resist designating more than about 10 percent of their land as protected areas, so there is clearly a need to balance conservation with sustainable use and sustainable development options to satisfy economic and social needs.

From a scientific standpoint, the scope for biodiversity conservation would be enhanced through the adoption of a landscape approach that involves a mosaic of land uses, including protected and production landscapes. There is also evidence that many species may only be conserved within a matrix of land uses, and that such spatial arrangements are necessary for long-term solutions.

Building on its experience and responding to new guidance from the Convention on Biological Diversity (CBD), GEF is embarking on strategic changes in the way it targets biodiversity conservation, including forests. In particular, GEF has adopted a program on Integrated Ecosystem Management that deals with forest conservation issues in a broader socioeconomic and political context. Recent support provided by GEF to China and Tanzania has sought to mainstream biodiversity considerations into forest-sector reforms.

Through its small grants program, GEF has supported about 40 projects to help biodiversity conservation within Brazil's vast Cerrado ecosystem. Project activities include extraction and commercial processing of medicinal plants, flowers, and native fruits; actions to control the use of fire; promotion of solar energy; income generation from ecotourism; and generation of sustainable livelihoods from beekeeping and other rural technologies.

Another important strategy that has emerged from this integrated approach is the use of "corridors" to connect protected areas into a much larger landscape. A mosaic of land use corridors enables wildlife to move across wider ranges, promotes genetic exchange, and helps preserve and increase existing populations. The Mesoamerican Biological Corridor in Central America, which GEF is supporting, has been a model of the corridor concept (Box 3.3).

New Economics

Production and consumption trends. Domestic demand for forest products is growing in relation to export demand, especially in developing countries; in fact, almost 90 percent of all commercial roundwood is traded domestically. For a variety of reasons, including the higher costs of natural forest management, forest plantations are gaining a competitive advantage over natural forests. In 2002, plantations occupied only 5 percent of the global forest cover but supplied 35 percent of global roundwood; this trend is expected to continue.

In Chile and New Zealand, plantation forests now meet all domestic wood needs and support a significant export industry. In Brazil, plantations supplied more than 70 percent of the industrial roundwood used in 1997, even though plantations cover only 4.5 million hectares, and natural forests cover over 360 million hectares. Asia's plantations accounted for 62 percent of the global industrial total in 2000, according to FAO. In Australia, Brazil, Chile, Indonesia, Malaysia, New Zealand, and South Africa, plantations are meeting the growing demand for wood, and this trend is expected to continue, with the private sector increasingly involved.

The expansion of plantations affects natural forest conservation in two ways. First, plantations decrease the pressure on natural forests for wood by generating alternative supplies. Yet their much higher productivity per hectare supplies the wood market with cheaper wood, indirectly diminishing the value of natural forests as wood producers and reducing the competitiveness of natural forests relative to alternative land uses.

Second, the collapse of production from natural forests would be unwelcome, particularly for the indigenous and other communities that have only recently begun to regain the authority to use their forest assets. Balancing the tradeoffs between plantation and natural forest supply, and strengthening the role of communities and smallholders in both of these activities will be increasingly important. The key issue is how to generate returns and revenue from natural forests.

Globalization. The increased globalization of the forest sector poses uncertainties for developing countries, but it provides opportunities as well. Investor and consumer demands for socially and environmentally responsible forestry are beginning to drive improved management. For example, socially responsible investment funds, with more than $1.4 trillion in assets under management, are developing positive indicators for sustainable forestry investments, using certification as a benchmark to verify sound practices in the global market.

This demand for sound forestry is also giving rise to a new generation of forest companies such as Global Forest Products in South Africa and Renewable Resources LLC in the Brazilian Amazon. These companies use business models that combine profitability with sound social and environmental management. With more communities and indigenous groups involved in forest ownership, many companies are forming partnerships with indigenous and other community suppliers. In Canada, Weyerhaeuser and other firms are joining with indigenous groups to manage natural forests and supply mills. There are now community–private sector partnerships in at least 57 countries.

Valuing forests. Forests provide a host of valuable ecological services. Although these have quantifiable economic value, they are generally provided at no cost. For example:

- Forests contain about two-thirds of known terrestrial species, have the highest species diversity of any ecosystem, and the highest number of threatened species. Most forest plant species, including timber trees and other forest products such as sago palms and rattans, depend on animal pollination for reproduction. Without a wide variety of forest habitats, animal pollination could be disrupted. Many plants, especially in tropical forests, also require animals for successful seed dispersal.
- Forest vegetation and soils hold almost 40 percent of all carbon stored in terrestrial ecosystems. And release of carbon as a result of deforestation contributes to global climate change. For example, a closed primary forest contains some 280 tons of carbon per hectare; if converted to pasture or permanent agriculture, it would release more than 200 tons of carbon into the atmosphere.
- By filtering freshwater and reducing soil erosion and sedimentation, forests play an important role in maintaining clean water supplies and reducing the severity of flooding. For example, erosion rates in slash-and-burn crop fields are 10 times higher than in natural forests. Road construction associated with logging, though only a small percentage of the logged area, can contribute as much as 80 percent of the sediment that enters streams.
- By providing shade and surface cooling, forests help moderate local temperature extremes.
- An estimated 99 percent of potential crop pests are controlled by natural enemies, many of which require forest habitats. If this natural pest control had to be replaced with chemical pesticides, the annual cost to U.S. agriculture alone is estimated at $54 billion.

Experience to date suggests that watershed protection can be an inexpensive way to save water and avoid the costs of filtration. In the United States, many cities have found that every $1 invested in watershed protection can save up to $200 in costs for new filtration and water treatment facilities. In South Africa, the Working for Water Program clears non-native tree species and increases streamflow at a fraction of the cost of new diversion or reservoir projects.

BOX 3.3

THE MESOAMERICAN BIOLOGICAL CORRIDOR

The Mesoamerican Biological Corridor, a GEF-funded project in Central America and southern Mexico, links a series of protected areas and buffer zones containing biological corridors of land with a variety of uses and degrees of protection. The project was officially endorsed by the governments of Mexico, Guatemala, Belize, El Salvador, Honduras, Nicaragua, Costa Rica, and Panama at a 1997 summit. All told, the Mesoamerican region covers 768,990 square kilometers, including 22 distinctive ecoregions and about 7 percent of the planet's biological diversity.

The project integrates biodiversity conservation in the region with sustainable uses of biodiversity within a framework of economic development priorities. Independent projects are under way in each country, and each government maintains its own environmental action plan. These activities are linked together through the Central American Commission for Environment and Development and exemplify the benefits of regional and subregional institutional cooperation.

The concept of creating "biological corridors" emerged in the aftermath of numerous civil conflicts and the inception of peace processes in the early 1990s. Even as numerous new national parks, biological and forest reserves, wildlife refuges, and biosphere reserves were being created as part of the Central American Protected Areas System, many biologists worried that these "islands" would be too small for many native species to survive. In 1994, a consortium of international conservation organizations introduced the Paseo Pantera project using corridors to link protected areas; this was later expanded to form the basis of the Mesoamerican Biological Corridor.

Source: Miller, Chang, and Johnson.

Forests also play an important economic role. Production of industrial roundwood is, of course, a vital part of the global economy. And in many developing nations, forests are an important source of livelihoods and resources, both for fuelwood and for other nonwood forest products.

Many people rely on fuelwood from forests, roadsides, community woodlots, and wood industry residues as a source of energy for heating and cooking. For developing countries as a whole, fuelwood provides about 35 percent of primary energy consumption. It is particularly significant in poorer countries, and for the poor within those countries.

Nonwood forest products are an important source of low-cost building materials, fuel, food supplements, and traditional medicines. In rural Madhya Pradesh, India, for example, a study found that these products provided 40–63 percent of total annual income. In Zimbabwe, extraction from wildlands for domestic uses accounts for about one-third of average household incomes.

Payments for ecological services. Traditionally, landowners receive no compensation for the environmental services their land generates. Recognition of this problem has led to the development of innovative payment systems. In some cases, private entities have developed their own mechanisms to pay for watershed protection—with little or no government involvement. In Colombia, for example, large agricultural producers in the Cauca Valley assess their own fees through water users' associations to finance watershed management practices in upland areas that will improve base flows and reduce sedimentation in irrigation canals. A regional public development agency carries out watershed management activities and provides technical assistance.

Currently, the most common example of new compensation systems involves public schemes, in which payments are made to private landowners and private or public resource managers. In Costa Rica, GEF supports an "ecomarkets" project that develops markets for environmental services provided by

forests and compensates private landowners for protecting biodiversity on their lands. In Ecuador, the municipal water authorities in the cities of Quito and Cuenca are allocating part of their revenues to protect their water sources. Quito receives the bulk of its water from several protected areas, and is paying for improved management in those areas.

In about six states in Brazil, an ecological value-added tax finances payments to landowners who maintain natural forests. This mechanism generates about $22 million a year in the state of Paraná and $6 million a year in Minas Gerais. In less than a decade, each state has placed more than 1 million hectares under protection.

For these compensation systems to be successful, a World Bank study found that payments need to be ongoing and carefully targeted, and that care needs to be taken to avoid inappropriate incentives.

New Politics

On the social and political front, significant new developments include increased community control of forests and greater attention to governance, international standards, and transparency mechanisms such as certification.

Community control. As part of the global trend toward decentralization and the recognition of indigenous and community rights, many developing nations are transferring either legal or administrative control over forests to indigenous and community groups. In the most forest-rich developing countries, nearly one-fourth of the forest estate is now legally owned (14 percent) or officially administered (8 percent) by indigenous and rural communities. Communities legally own or administer at least 380 million hectares of forest. The percentage of forest under community control has doubled in the last 10 years, and could double again by 2020. This change is supported by parallel trends in many countries to reform land tenure and enhance the security of private property rights.

This transition represents great progress in rationalizing and securing forest ownership and establishing more conducive conditions for sustainable forest management, as well as a historic opportunity to dramatically improve the livelihoods of millions of forest inhabitants.

Certification. When efforts to halt deforestation in tropical forests made little progress in the late 1980s and early 1990s, some environmental groups began thinking about ways to encourage markets to give preference to timber from sustainably managed tropical forests. The result was forest certification, a procedure that uses predetermined standards to assure the quality of forest management operations. Certification may include an agreement on the right or license to use a special label on traded forest products, coupled with independent verification of compliance to these standards.

Since the early 1990s, some important strides have been made in forest certification:

- The area certified by accredited certifiers of the Forest Stewardship Council has reached 22 million hectares, up from 10 million in 1998. Sweden and Poland account for 61 percent of the total.
- In Europe, 21.9 million hectares of Finland's forests have been certified under the Finnish Forest Certification System; another 6.9 million hectares have been certified in Norway and Sweden under national certification schemes. And in Canada, about 44 million hectares of forestland have been certified according to the ISO 14001 standard of the International Organization for Standardization.
- The Pan-European Forest Certification Framework provides a mechanism for mutual recognition among different European national systems.
- The Indonesia Ecolabelling Institute (LEI) has developed criteria and indicators for the auditing of forest management on logging concessions, as well as ecolabelling of products from these

concessions. LEI issued its first certificate of good forest management in April 2001 for 91,000 hectares of forest managed by a company operating in central Sumatra.

- Malaysia has formed a National Timber Certification Council.
- B&Q, a leading home improvement chain in the United Kingdom, has agreed to accept Finnish timber certified under the Finnish Forest Certification System. In the United States, several retail chains and major homebuilders have announced that they will favor certified wood products in the future. Buyers' groups have expanded, with notable commitments recently from some large retailers in Brazil.
- Forest certification has pioneered the way for other certification schemes in the marine, tourism, and aquarium fish trades.

Even with these encouraging developments, however, the future effectiveness of forest certification is widely debated. The area of certified forests is growing rapidly but still represents only about 2 percent of the world's total forest area, and most certified forests are located in a limited number of temperate countries rather than in tropical ones. In general, countries with large areas of tropical forest export only a low percentage of their products to the most environmentally sensitive markets in Europe. And certification does not seem to be a driver for the development of national land-use strategies that include biodiversity conservation and other sustainability factors. Finally, certification relies on a long and detailed set of criteria and indicators that may deter implementation by logging and forest management teams.

In developing countries, certification's greatest contribution to date has been to stimulate new debate on forest practice and the development of new standards in an inclusive, participatory manner. Certification is increasingly used by investors and insurers to indicate reduced risk and uncertainty in forest operations. Certification's greatest potential will most likely be in the area of forest services. Independent certification is an essential element of the institutional framework required by markets for forest services. Building this framework will be a major challenge in the coming decades.

New global conventions. International negotiations aimed at developing a global forest convention began in 1990, but during the negotiations at the 1992 Rio Earth Summit it became clear that there was no consensus on the contents of such a treaty. However, there are at least 10 multilateral agreements in which forests are a significant issue. For example, the U.N. Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD), and the U.N. Convention to Combat Desertification (UNCCD) have significant scope to improve forest management. Under the Kyoto Protocol to the UNFCCC, certain human-induced activities that remove greenhouse gases from the atmosphere—including afforestation, reforestation, and reduced deforestation—may be used by industrial countries to offset their emission targets.

The parties to the CBD have progressively strengthened the role of forests in maintaining biological diversity. A work program adopted in 1996 provides a strong basis for delivering the objectives of the convention within a broader socioeconomic context. Emphasis is on research, cooperation, and development of technologies necessary for the conservation and sustainable use of forest biological diversity. CBD also has influenced the global dialogue on forests through its recognition of the traditional forest-related knowledge of indigenous peoples. Another influential link with forests is made through the GEF, which provides funding for CBD for projects that support forest biological diversity. GEF's forest program accounts for almost 40 percent of its entire biodiversity portfolio, with funding of $540 million and cofinancing of $1.1 billion. Even these estimates are conservative, because forest ecosystems are included in other GEF operational programs.

Protection and expansion of forests also are important elements in the UNCCD, since forests help mitigate the effects of drought and prevent desertification. Sustainable forest management is an important part of the corrective actions under UNCCD to reduce land degradation.

Other important conventions relating to forests include the Ramsar Convention on Wetlands of International Importance, the Convention for the Protection of the World Cultural and Natural Heritage, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the Convention Concerning Indigenous and Tribal Peoples in Independent Countries, the International Tropical Timber Agreement, and the Agreement Establishing the World Trade Organization. The GEF has provided substantial funding in support of some of these priorities (Table 3.3).

While the continuing lack of consensus about the elements of a global forest convention appear to preclude any consolidation of agreements into a single treaty in the near future, the scope for existing conventions to address the issue of sound forest management, including biodiversity conservation, must be a priority. In this context, the interagency cooperation between the secretariats of the CBD,

TABLE 3.3

GEF Projects in Globally Significant Biological Areas[a] (FY 2001)

Areas Listed in:	No. of GEF Financed Projects	GEF Allocation ($ million)
World Natural and Cultural Heritage Sites[b]	29	177.58
Global 200[c]	60	401.33
RAMSAR[d]	10	61.45
UNESCO MAB Reserve[e]	53	300.18

Notes:
a. Based on analysis of GEF's forest program only. For example, including Ramsar sites funded by GEF's Coastal, Marine, and Freshwater program would increase this category to 35 sites and the funding level to over $180 million.
b. World Natural and Cultural Heritage Sites list (as of December 1999)
c. World Wildlife Fund Global 200 list—a representative approach to conserving the Earth's Distinctive Ecoregions (as of March 1998)
d. Convention on Wetlands of Importance, especially as Waterfowl Habitat (RAMSAR, 1971)
e. UNESCO Man and the Biosphere Program list (as of March 1998)

Source: GEF.

UNFCCC and UNCCD, as well as the role of the Collaborative Partnership on Forests, must be fully exploited.

AN AGENDA FOR FORESTS

The agenda for forests in the coming decade must address a wide array of issues. Three are particularly significant: creating a conservation infrastructure; providing incentives for conservation and sustainable forest management; and intensifying efforts to scale up and replicate successful initiatives.

The agenda described here was drawn largely from the GEF Roundtable on Forests held in New York in March 2002; from the summary of the roundtable prepared by Jeffrey Sayer, roundtable chair and senior associate at the World Wide Fund for Nature; and from a background paper prepared for the roundtable by Andy White, the director of Forest Trends.

A Conservation Infrastructure

Better governance in developing countries could improve incentives for conservation-oriented private-sector participation, encourage more effective models of community forest management, and generate international support and additional financial resources for public forest management.

Costa Rica's exemplary management of forests hinges on the fact that it has invested substantially in its institutional and legislative framework and nurtured capacity so that public, private, and community stakeholders can benefit from forest conservation measures. The challenge for developing countries is to create or strengthen their "conservation infrastructure" so they have the tools and capacity needed to capitalize on and benefit from opportunities in the forest and other related sectors. Targeting policies, institutional frameworks, and human capacity is critical.

Another important challenge is to develop a new generation of institutions with the capacity to deal

with the complexity and unpredictability of forest systems; manage across jurisdictions, from the subregional to the national level; deal with forest problems in an integrative, holistic way; and create markets to enable payments for ecosystem services.

Greater integration of resource management should be sought at decentralized levels of governance. Stronger institutions are needed to address resource management issues that cross national borders, and to operate at the subnational level in situations such as large catchments.

At the local level, governments should continue to support a shift in forest ownership to communities and smallholders, and pragmatic capacity building. Clear tenure rights enable local people both to protect forests from outside encroachment and to enter into business contracts.

In Indonesia and the Philippines, some local groups have successfully negotiated new rights by demonstrating effective sustainable forest management.

Key steps in supporting this transition include:

- *Identifying and clarifying property rights.* In most countries, additional laws are needed to strengthen property rights for forest ecosystem services; this will facilitate the development of markets for environmental services.
- *Building and enhancing local capacity.* Training and capacity building at the community level will empower local people to organize themselves to generate sustained income from forests—through ecotourism, timber certification, carbon sequestration, and other payment schemes.
- *Developing and sharing transition strategies, lessons, and best practices.* Governments and policymakers will benefit from information about successes and failures in reforming tenure systems. Equally important is the need to expand knowledge-sharing among field practitioners by arranging exchange visits to innovative projects, and by encouraging replication and scaling-up by communities.
- *Increasing investments.* Industrial countries as well as multilateral and bilateral organizations need to increase financial assistance for tenure reform to include assessing community claims, mapping tenure, delimiting property, reforming legal frameworks, and devising regulations.

At the international level, financial and technical assistance agencies should increase support for forest management and conservation reforms in developing countries by:

- *Assessing the performance of public timber concessions and adopting necessary reforms.* Following the example of Cambodia, governments could review the extent to which companies holding concessions are conforming with legally agreed-upon obligations and could cancel or reissue those in default.
- *Controlling illegal logging and corruption.* A number of countries are improving the monitoring of logging activities. Reducing financially competitive illegal and unsustainable activities would help make forest conservation and sustainable management financially attractive.
- *Developing and strengthening independent certification standards and national auditing capacity.* Certification can effectively support

governance, yet national-level capacity is often limited, thereby increasing the costs of adoption.

- *Adopting systematic independent audits of government performance in public forest management.* Several countries, notably Malaysia, have adopted a process of independent audits. These assessments help governments check their own performance and provide assurance to citizens and buyers.
- *Setting conservation goals.* Governments could heighten the visibility of forest conservation by creating conservation goals.

Incentives for Conservation

Policy reforms can encourage investment, help make forests more competitive with alternate land uses, and strengthen the role of forestry in poverty reduction. Reducing the regulatory burden on local forest producers can help them use their own forests or public stands to enter markets. In many cases, regulations can be replaced by technical assistance programs that promote and monitor best practices, or by certification. But the requirements of forest management plans and certification programs need to be simplified if small-scale producers are to comply and benefit from them.

It is also important to level the playing field for small-scale producers. In Bolivia, forest policy reforms have included formal recognition of indigenous groups' forest rights and have exempted small-scale forest producers from some requirements. Reforms included lower concession fees, a simplified process for accessing municipal forests, and assistance with marketing and forest certification. In addition, the active involvement of local producers in forest policy negotiations will lead to more practical, realistic, and lower-cost laws, market regulations, and development plans.

Promoting community forest enterprises and joint ventures is important. There are many examples of sound community management where forest harvest levels appear sustainable, and where benefits are distributed to community members. In Mexico, for example, community-owned forests contribute substantially to community livelihoods and domestic wood supply.

There are important new opportunities for smallholders and communities in managing forests, especially given the reduced supply of tropical hardwoods and the increased environmental conscience of investors and forest product companies. Capturing these opportunities will require a number of steps, including:

- *Characterizing and establishing markets for low-income producers.* Preliminary studies indicate there is high potential for low-income producers, but more research is needed to better characterize the potential in each market segment, identify where the potential is strongest, and describe the steps required to enable community participation.
- *Improving market position.* Long-term growth in timber and nontimber forest products requires building supply networks that link producers to domestic markets with increased production efficiency. To raise incomes significantly, producers need to establish a competitive position. This may mean improving production and marketing technology, product quality, and reliability of supply.
- *Strengthening producer organizations.* Where market institutions are underdeveloped, producer organizations can fill the gaps by, for example, setting up transport services, scaling up supply, or leveraging credit. Producer organizations also need to develop the skills to make capital investments and establish and maintain quality controls.
- *Promoting strategic business partnerships.* Partnerships can benefit both private industry and local producers. Industrial firms gain access to wood fiber and nonwood products at a competitive cost, while local producers can obtain high-quality planting materials, technical assistance, quality control, and investment resources for expansion, marketing, and business expertise. In Canada, for example, Iisaak Forest Resources is jointly owned by the First Nations groups of Clayoquot Sound and

Weyerhaeuser as a way of conserving and managing valuable old-growth forests that are not formally protected.

- *Promoting essential business services.* Some private firms, such as A2R in Brazil, and some public projects are making concerted efforts to build private-sector capacity in forest settings, including management services; organizational support; technical assistance for production, conservation, and processing; market information and marketing assistance; insurance; and financing.

Several steps could help promote the development of markets and market-based mechanisms to finance forest ecosystem services. First, there is a great need for more information about the biophysical relationships between forest management activities and the flow of services, and on how to ensure that the poor participate fully in and benefit from such markets. Second, all markets require enabling institutions in areas such as common assessment methodologies, property rights, certification systems, and contracts. In the carbon market, particular challenges include devising approaches to deal with leakage, permanence, and accessibility issues. Third, the existing stock of knowledge comes from innovators who have forged ahead despite uncertainty. Encouraging such efforts will provide greater experience and certainty about how to develop market-based mechanisms successfully.

International market-based payment mechanisms could provide an opportunity for industrial countries to invest in developing-country forests. Innovative funds, such as the World Bank's Prototype Carbon Fund, have helped build experience and capacity in the international markets area. The new Prototype Sequestration Fund will similarly set precedents in the forest carbon markets.

The Clean Development Mechanism (CDM) of the Kyoto Protocol precludes global payments for carbon sequestration services of natural forests. Donors, governments, and new investors can transform the CDM into a more effective tool for conservation and development. Rules and funding mechanisms should be devised to support natural regeneration and reduce the transaction costs of community participation. New, biodiversity-oriented funding mechanisms could address some of the limitations of existing international mechanisms. A global fund could be financed by both governments and private donations.

FOREST AND BIODIVERSITY TARGETS FOR 2015

- Conserve 10 percent of the world's ecological regions.
- Protect 50 percent of the most important areas for plant diversity, assuring that 30 percent of plant-based products are sustainably managed.
- Conserve 70 percent of the genetic diversity of crops and other economically valuable plants.
- Conserve 60 percent of the world's threatened species *in situ*.
- Establish and monitor national targets for natural resources and ecosystems in full consultation with stakeholders.

These global targets should be complemented by national targets. Forests and biodiversity conditions vary considerably from country to country, and national targets should be established and monitored in full consultation with local and regional stakeholders.

Scaling Up and Replication

A key challenge, particularly for institutions such as GEF, is to develop individual projects that can be recreated on a larger scale and used elsewhere.

Several GEF biodiversity projects have been replicated by governments, conservationists, and local populations.

- Trust funds initiated in the Uganda Mgahinga Gorilla National Park and Bwindi Impenetrable National Park projects have produced sustainable funding for GEF biodiversity projects in a country where budget allocations for conservation are very low.
- An integrated management system developed for the Dana Nature Reserve in Jordan has been applied to all five other protected areas in the country.
- The success of the Southern Africa Botanical Network in capacity development for taxonomy has been replicated in Eastern Africa and the Caribbean.
- In Samoa, the Marine Protected Area project has raised extensive community support, and other villages are copying the project.

One important way to encourage scaling up and replication is through further cooperation with the private sector. GEF is building direct partnerships with private-sector entities, UNDP is involving major companies in biodiversity conservation as cofunders and sources of advice, and the World Bank and International Finance Corporation are catalyzing private-sector participation in the climate portfolio through instruments such as the Prototype Carbon Fund.

Natural resource management projects can be sustained and enlarged when they generate work, income, and economic progress. GEF has used a variety of instruments to encourage such outcomes, including direct investment, subsidies, credits, conservation trusts, and alternative livelihood activities.

Education and outreach also are important tools to encourage scaling up and replication. In Africa, GEF has disseminated information about project activities and ways to manage global environmental issues through outreach programs, interpretation centers, signage, and newsletters. In Uganda, for example, key awareness messages on the global benefits of managing the Minziro forest are yielding tangible results: 8,400 people in more than 1,800 households in three villages are promoting reforestation.

"The protection of the environment and sustainable development are equally pressing challenges of our time."

Fernando Henrique Cardoso
President of Brazil

Another valuable strategy is to broaden the base of public consultation. For example, the GEF has helped to develop an NGO culture in some countries where such groups are not routinely accepted. There is a similar need to engage a broad range of entities in the private sector.

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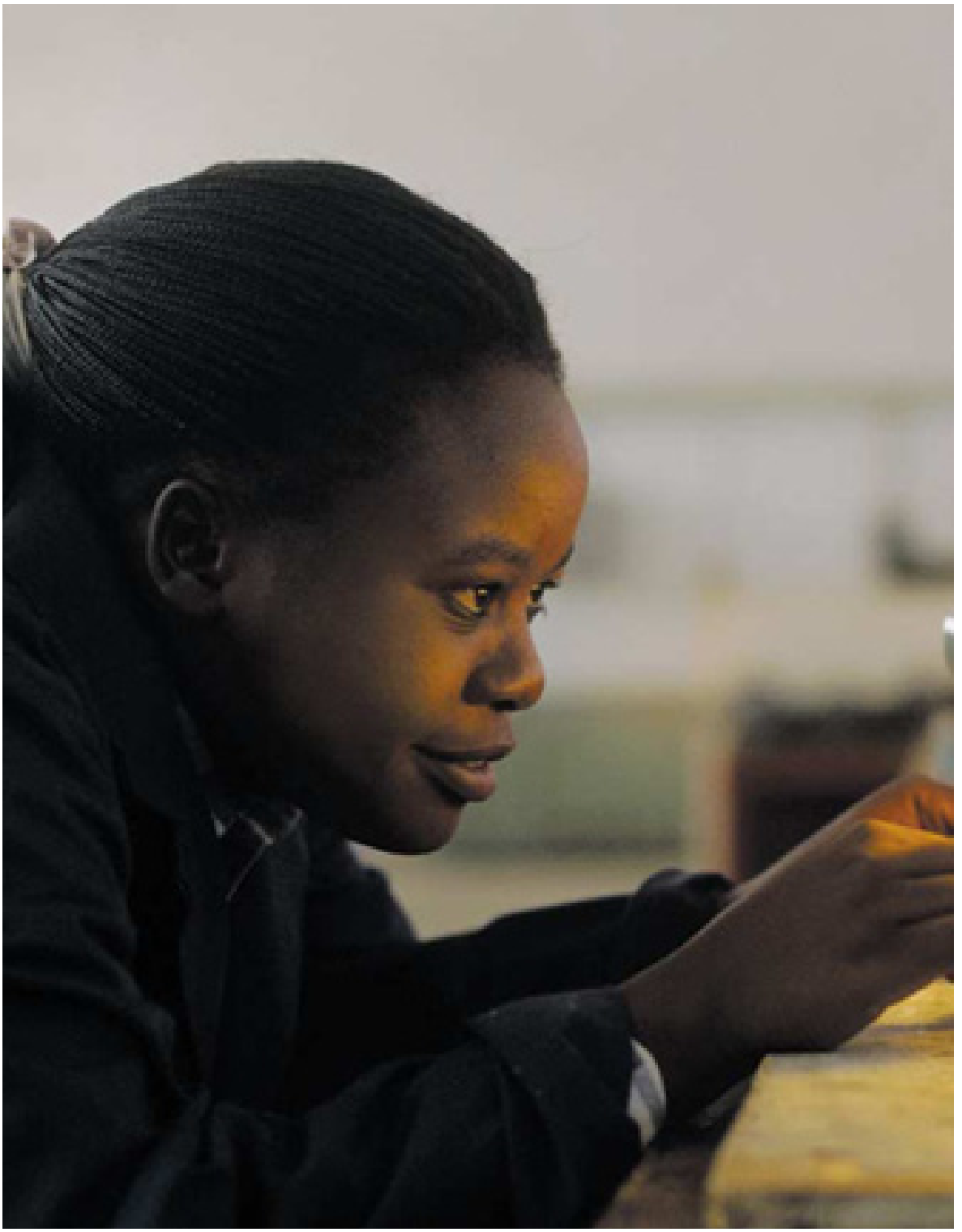


ENERGY: POWERING SUSTAINABLE DEVELOPMENT 4

Energy is the lifeblood of the global economy. It provides the fuel for cars, trains, and planes, for basic industries, and for communications, electricity, light, and heating. It is vital for economic growth and development. It can improve the quality of people's lives and their productivity. It can extend the working day and provide additional time for activities such as education and health care. And in developing nations, modern forms of energy can liberate millions of women and children from the burden of gathering water and fuelwood.

Three issues dominate the energy agenda today:

- *Availability and access:* the need to expand the supply of energy, especially in the developing world and to those who currently lack access to modern energy sources
- *Environmental impacts:* the implications of current energy production and use, and further expansion
- *Policy:* the opportunities to use new knowledge, policies, and incentives to reshape future energy development in order to reduce poverty, improve the quality of life, and produce better environmental outcomes.

First, energy availability is limited, particularly in the developing world. Some 2 billion people who do not have access to electricity must rely on traditional fuels such as dung and fuelwood. To reduce poverty

and meet growing demand, developing countries must generate more energy.

Second, energy—especially from fossil fuels—has significant environmental implications. Local air pollution causes perhaps 4 million premature deaths per year, mostly of young children exposed to dirty cooking fuels. The economic costs of air pollution are substantial, perhaps $350 billion per year, or 6 percent of the gross national product of developing countries. Emissions of sulfur dioxide and nitrogen oxide also have been found to damage crops, forests, rivers, and lakes.

In terms of climate change, the risks posed by the current approach to energy are at best difficult and at worst potentially catastrophic. Fossil fuels (coal, oil, and natural gas) now account for about 80 percent of world consumption of primary energy. The combustion of fossil fuels adds carbon dioxide (CO_2) to the atmosphere. CO_2, in combination with other greenhouse gases such as methane and nitrous oxide, traps heat in the upper atmosphere. Though the process is complex and not completely understood, there is consensus among scientists that emissions of greenhouse gases have altered the global climate, and that a further expansion in these emissions could have devastating environmental effects. If, as predicted, carbon emissions double from today's levels by 2050, global average temperatures could rise a further 1.0–3.5 degrees Celsius by 2100.

Third, energy production and consumption trends are sensitive to policies and incentives and therefore can change, particularly as new knowledge about the environmental consequences of an approach dominated by fossil fuels becomes available and is widely disseminated and understood. Since the mid-1980s, many policymakers, government officials, and business leaders—including those from oil companies—have changed their thinking about sustainable energy development. Actions have centered on three main areas: improvements in efficiency to obtain more energy services with less primary energy use, the spread of renewable energy sources, and efforts to provide more than 400 million rural households with access to modern energy services.

Around the world, the transition to renewable energy systems has already begun. Private investors, governments, and multilateral assistance agencies are shifting their attention and investment shares to renewable energy. At the 2000 G-8 Summit in Okinawa, Japan, assembled ministers for the first time publicly recognized the importance of renewable energy, saying, "We call on all stakeholders to identify the barriers and solutions to elevating the level of renewable energy supply and distribution in developing countries." Shell and British Petroleum have each committed $500 million for renewable energy investments. In addition, some countries, including China and India, are proposing domestic targets for renewable energy that range from 5 to 15 percent of new electricity supply within 10 to 20 years.

A transition to renewable energy is inevitable—not because fossil fuel supplies will run out, but because the costs and risks of using these supplies will continue to increase relative to renewable energy. Costs will increase as the environmental effects of fossil fuel use are incorporated into the costs of energy and as the cheapest reserves are depleted. Risks can increase as fossil fuel prices and availability become more variable due to such factors as privatization, deregulation, and political instability. Renewable energy helps alleviate fuel price risks. As the costs of using it continue to fall, renewable energy is expected to overtake fossil fuels as the lowest cost, least-risk investment over the next several decades.

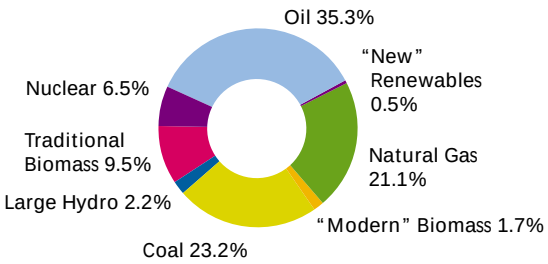
But how quickly will this transition take place? By the latter half of the twenty-first century, as experts predict? Development agencies, many governments, and environmentalists would like to accelerate the process so that it occurs within the next few decades, because this switch will have enormous economic, social, and environmental benefits.

DEPENDING ON DIRTY FUELS

Fossil fuels dominate world energy consumption. In 1998, they accounted for nearly 80 percent of primary energy consumption, followed by renewables (13.9 percent) and nuclear energy (6.5 percent). Oil accounted for about 35 percent of the total, followed by coal (23 percent) and natural gas (21 percent). Traditional biomass accounted for about 9.5 percent (Figure 4.1).

FIGURE 4.1

World Energy Consumption by Fuel Type, 1998



Population: 5.90 billion Fossil fuels: 80%
Energy: 10,56 x 106 toe (1.79 toe/capita)

Toe = tons of oil equivalent.
Source: World Energy Assessment.

About 2 billion people depend on traditional biomass sources. Wood, dung, and other biomass fuels are the dominant fuel sources for poor people; as incomes rise, people move up the "energy ladder" to charcoal, coal, and kerosene, and ultimately to electricity and liquefied petroleum gas (LPG).

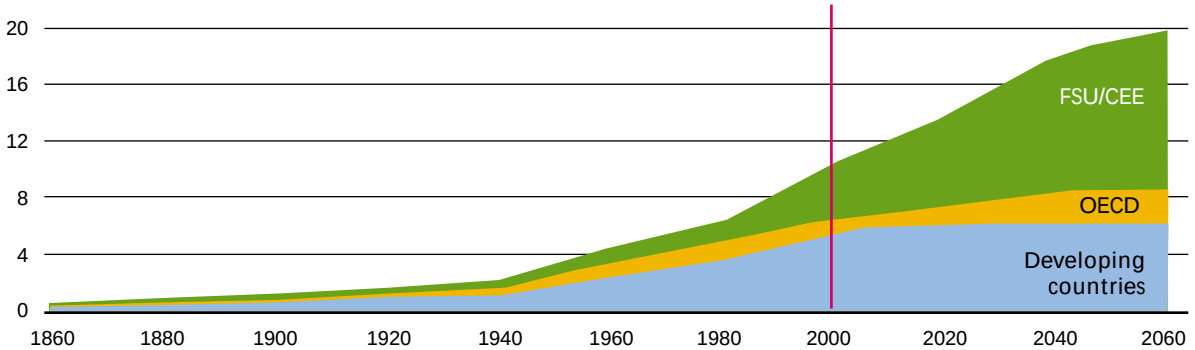
The poor pay more for—or spend more time getting—energy services. In many cases, studies have found that poor households could significantly reduce their daily costs if they could move up the energy ladder to LPG or electricity. In turn, the gains in purchasing power would be applied to basic needs for food, shelter, clothing, health, education, and additional fuel. Access to modern energy sources could, therefore, have a substantial and positive impact by reducing poverty and increasing rural jobs.

From 1970 to 1998, global use of primary energy expanded by about 2 percent each year, according to the *World Energy Assessment*. But during the latter part of that period, in the 1990s, annual growth slowed to about 1 percent, largely because of the economic collapse of transitional economies in Eastern Europe and the former Soviet Union and the 1997–98 financial crisis in Asia.

FIGURE 4.2

Growth in Primary Energy Consumption, 1860–2060

Gtoe



Note: The graph projects future energy consumption (2000–2060) based on current trends; Gtoe = gigatons of oil equivalent; FSU/CEE: Former Soviet Union/Central Eastern Europe; OECD: Organisation for Economic Co-operation and Development.

Source: World Bank, *Fuel for Thought*, 2000.

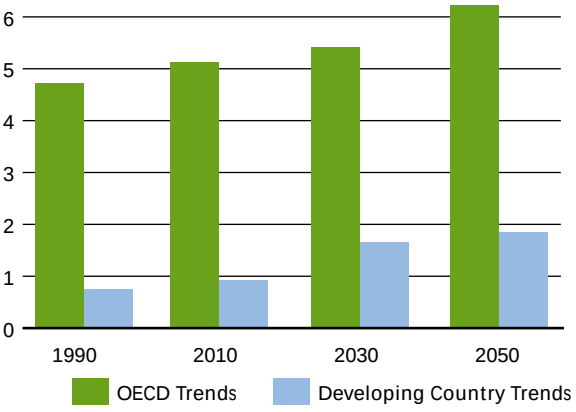
Energy use in developing countries has increased three to four times faster than in western industrial countries. As a result, developing countries' share of energy use rose from 13 percent in 1970 to almost 30 percent in 1998. Still, the gap in per capita electricity use between industrial and developing countries stayed about the same. In the least-developed countries, annual per capita electricity use is estimated at 83 kilowatt-hours—only about 1 percent of the 8,053 kilowatt-hours consumed per capita in OECD nations.

Based on current trends, world energy use will grow at an annual rate of about 2.6 percent in developing countries, according to the *World Energy Assessment*. By 2015, the World Bank estimates that developing countries will have matched the total consumption of industrial countries; by 2050, they will have doubled it (Figure 4.2). Even at that point, however, energy consumption per capita in developing countries will still be only one-fourth that in industrial nations (Figure 4.3). Fossil fuels will still account for almost two-thirds of primary energy production by 2030 (Figure 4.4).

FIGURE 4.3

Per Capita Energy Use, 1990–2050

Toe/person



Toe = tons of oil equivalent.
Source: World Bank, *Fuel for Thought,* 2000.

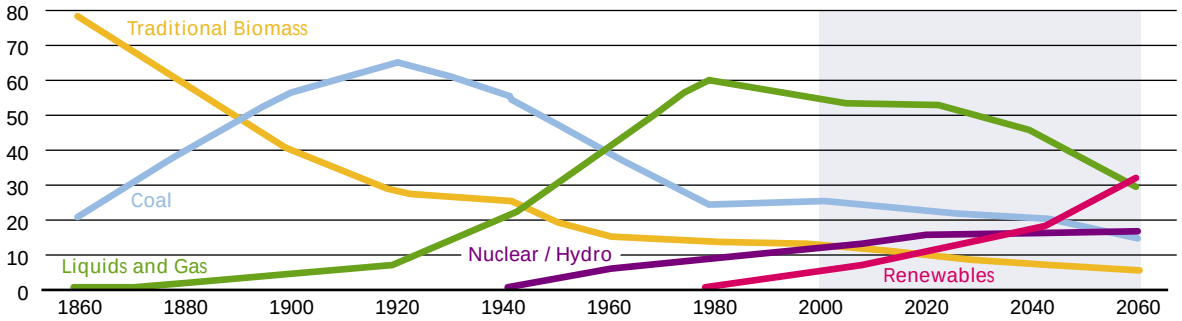
HIDDEN COSTS OF DIRTY FUELS

In about half of the world's households, people use biomass and coal for cooking and heating. These fuels emit large amounts of pollutants, which in many cases are not vented from the home and

FIGURE 4.4

Projected Growth in Renewable Energy Use

Percentage Share



Note: Renewables include solar, wind, small hydropower, geothermal, and modern biomass. For 2000-2060, the graph provides one possible scenario of future energy consumption that shows renewables having the highest share. The scenario is not extrapolated from current trends.

Source: World Bank, *Fuel for Thought,* 2000.

create substantial indoor air pollution. The principal health effects include chronic respiratory diseases such as bronchitis and asthma.

In India, studies have found that household use of solid fuel causes about 500,000 premature deaths each year among women and children under the age of 5. This is 5–6 percent of the national burden of ill health, and 6–9 percent of the burden for these two population groups. The global impact is thought to be about four times larger, or about 2 million premature deaths a year among women and young children.

In communities and urban areas, fuel combustion emits large amounts of fine particles that lodge deep in the lungs and have significant health effects. Atmospheric particle concentrations and other pollutants are thought to cause 170,000–290,000 premature deaths annually in cities in China and 90,000–200,000 deaths in India's urban areas. The causes of urban pollution in developing countries are varied, but include power plants and large industries with limited pollution controls; large numbers of small boilers, engines, and open fires; two- and three-wheel vehicles with highly polluting two-stroke engines; and emissions from cars and trucks powered by diesel fuel.

At the regional level, energy activities account for 82 percent of sulfur dioxide and 76 percent of nitrogen oxide emissions. These pollutants can be transformed into acids in the atmosphere. Studies have found that acid deposition can harm aquatic life in lakes and rivers. At high elevations, acid deposition can increase the susceptibility of forests to natural stresses and cause a loss of nutrients in the soil. Acid deposition also can be harmful to humans; for example, many respiratory diseases are likely caused or aggravated by sulfur particulates and nitrogen oxides in acid fog.

At the global level, fossil fuel combustion plays a major role in the buildup of carbon dioxide (Box 4.1). Increases in the atmospheric concentration of CO_2 closely parallel the rise in global fossil fuel burning over the past 150 years. Since the pre-industrial period, CO_2 concentrations are estimated to have risen about 29 percent, causing an increase in near-surface air temperatures of 0.3–0.6 degrees Celsius since the late nineteenth century. The Intergovernmental Panel on Climate Change (IPCC) estimates that as CO_2 concentrations continue to increase, global average surface temperatures will be 1.0–3.5 degrees Celsius higher in 2100 than in 1990. At mid-latitudes, the increase is likely to be 1.3–2.0 times higher than the global average; in higher latitudes, the increase could be three times the global average.

The likely effects of global warming include disruptions in the productivity of farms, forests, and fisheries; changes in the geographic distribution of human disease; increased frequency and intensity of storms and floods; and rising sea levels. The cost in developing countries is estimated at 5–9 percent of gross domestic product (GDP)—considerably worse than in industrial nations.

The cumulative rise in carbon emissions varies considerably, depending on the future fuel mix. In a coal-intensive scenario, carbon concentrations in the atmosphere could rise from the current 370 parts per million by volume (ppmv) to about 730 ppmv by 2100, about twice current levels. Under more sustainable scenarios, concentrations are projected to rise to the 450–600 ppmv range. In nearly all scenarios, concentrations continue to rise throughout the twenty-first century.

Virtually all future energy-use scenarios show that sustainable futures are not possible if development continues along a business-as-usual path. These scenarios require at least moderate policy and behavioral changes that are consistently applied over several decades. In time, such changes could result in a substantially changed energy future.

BOX 4.1

THE CLIMATE CHALLENGE

Governments, private companies, and NGOs have been debating what to do about climate change since the UNFCC was adopted in 1992. A protocol negotiated in Kyoto, Japan, in 1997 would amend the climate change convention and require modest reductions in greenhouse gas emissions by 2012 relative to 1990 levels, but only in industrial countries. One key feature of the Kyoto Protocol is a provision on emissions trading that would allow industrial countries to invest in developing countries that offer less expensive means of reducing emissions but also support the transfer of clean energy technologies. The Protocol is not yet in effect, but it may be soon in light of additional agreements signed in Marrakesh, Morocco, in November 2001. Even countries that have so far chosen not to participate, such as the United States, recognize the need for at least some domestic measures to address climate change.

As countries continue to consider short-term responses, there is little disagreement about the dramatic nature of the long-term transition that may be needed. Because of the long-lived nature of carbon dioxide and most greenhouse gases, global emission reductions in the range of 60–70 percent relative to current levels may be necessary in the coming decades. This will need to be accomplished even as the global population multiplies and the level of economic activity expands. Improved energy efficiency and new technologies for carbon sequestration will play important roles. But no lasting solution is possible without a transition from carbon-intensive fuels to solar power and other renewable energy sources. The transition will require decades—but aggressive research and development and market introduction must begin now.

THE IMPETUS FOR CLEAN FUELS

The 1992 Rio Earth Summit had a variety of direct and indirect impacts on sustainable energy development.

Two immediate outcomes included the UNFCC and the establishment of the GEF. The climate convention and the subsequent Kyoto Protocol have already led to some adjustments in energy consumption and greenhouse gas emissions among a few of the signatory countries. GEF was initiated in 1991 as a pilot program to earmark multilateral funds for developing-country-based projects with global environmental benefits. Following the Rio Earth Summit, GEF was designated as the financial mechanism for both the CBD and the climate change treaty. In the energy area, GEF has since 1991 provided more than $1.2 billion in grants for projects with a total value of more than $6 billion.

The Rio Summit also helped strengthen and legitimize the role of NGOs. Further, it increased the political importance of science, technology, and the environment in developing countries, which in some cases resulted in the creation of cabinet-level environment departments. Many recent government programs for energy efficiency and renewable energy are linked to this trend.

There has also been increased recognition that clean energy is essential for development and the attainment of basic human needs, especially in rural areas of developing countries; for environmental quality, especially in urban areas; and for security, both in terms of reliability of energy supply and protection against price volatility.

In addition, the 1992 Summit helped build momentum for:

- Sustainable energy development, including the increased use of renewable energy
- Increased private investment in renewable energy and energy efficiency

- Greater reliance on markets and the private sector
- Power sector reform and utility restructuring
- Declining energy intensities.

Increased Use of Renewable Energy

Especially in rural areas, there have been significant improvements in access to commercial energy over the past decade, including access to LPG, modern biogas, and village-scale electricity grids. Use of renewable energy, including solar, wind, and small hydropower, also has increased dramatically.

For example, solar home systems using photovoltaic (PV) technology, which was virtually unknown in 1992, now provide lighting, television, and radio to more than 1 million rural households. Thousands of rural communities now receive drinking water from solar PV-powered purifiers and pumps. Small hydropower and biomass generation capacity worldwide increased 20–30 percent over the past decade, to 25,000 megawatts and 16,000 megawatts, respectively. More than 50 million households are served by small-hydro village-scale mini-grids, mostly in China. Wind power generation capacity has increased from virtually zero to over 1,700 megawatts, mostly in India. In addition, the number of households served by solar hot water heaters has tripled, to roughly 10 million households, mostly in China. Programs for improved biomass cooking stoves in China, India, and several African countries have benefited some 220 million households through reduced fuel costs or fuelwood collection burdens.

Increased Private Investment in Renewable Energy and Energy Efficiency

With the encouragement of the World Business Council for Sustainable Development and other business councils in industrial and developing countries, a large number of leading industries have become increasingly engaged in renewable energy and energy efficiency investments. It is estimated that between $500 million and $1.5 billion of renewable energy projects in developing countries are being financed each year, a market that is growing 5–10 percent annually.

At least 30 major firms have made commitments to invest billions of dollars in renewable energy over the next two to five years. Shell International Renewables was one of the first to make a large-scale commitment, with $500 million pledged in 1998. Others have since followed with similar commitments, some for over $1 billion. Total commitments now amount to at least $10–$15 billion.

Greater Reliance on Markets and the Private Sector

During the past decade, commercial markets for renewable energy have expanded, shifting investment patterns away from traditional government and international donor sources to greater reliance on private firms and banks. These changing investment patterns have made it more important to think about markets for renewable energy, along with the policy and social conditions that underlie markets, rather than simply about the technologies themselves and their economic characteristics. The policy and social conditions vary widely from country to country, resulting in a diverse range of market conditions that require a similarly diverse range of market-oriented approaches. Changing investment patterns also elicit increased decisionmaking and participation from a wider variety of stakeholders—not just traditional donor agencies and governments, but also manufacturers, rural entrepreneurs, individual households, local technicians, NGOs, community groups, utility companies, and commercial banks.

These are recent examples:

- In Koudia el Baida, Morocco, a 50-watt wind farm is one of several wind projects in developing countries to be constructed largely on commercial terms. A consortium of three firms, including Electricité de France, is building and operating the farm with financing from a number of commercial and development banks. With exceptional wind resources, the facility was expected to provide an unprecedented capacity factor of 46 percent when it began operation in late 2000. Ownership of the wind farm will be

ceded to the Moroccan national electric utility, Office National de l'Electricité (ONE), at the start of operations. The power purchase agreement with the consortium extends 19 years and provides full cost recovery. In 2000, ONE solicited bids for two additional wind farms totaling 200 megawatts. In the Dominican Republic, the U.S. firm Soluz is developing a subsidiary, Soluz Dominicana, as a successful fee-for-service business. The company targets up to 50 percent of the population in the rural communities it serves and charges $10–$20 a month for electricity service from solar home systems. By continuously improving this business model, Soluz expects to expand Soluz Dominicana to include 5,000 fee-for-service customers. At this scale, revenues should cover the direct costs of operations. Soluz has begun replicating the fee-for-service concept in Central America by establishing Soluz Honduras.

- In Cebu in the Philippines, the WorldWater Corporation will supply water to about 100,000 people through a program that combines solar-powered water pumping technology, full cost recovery through pay-for-service methods, and community education about the benefits of the technology. Under the full program, a total of 110 *barangays* (villages) in 26 municipalities will be provided with solar-powered water pumping and distribution systems. The Development Bank of the Philippines, Land Bank, and the Philippines National Bank will provide loans estimated at $10 million for this program.

Power Sector Reform and Utility Restructuring

Many developing countries are either beginning to consider or already have power sector reforms in place, driven primarily by free-market, privatization, and institutional efficiency agendas. Globally, six key trends in power sector reform are most relevant to sustainable energy in developing countries:

- competitive wholesale power markets and removal of price regulation on generation
- self-generation by end-users
- smaller-scale generation facilities and technologies
- privatization or commercialization of utilities
- unbundling of generation, transmission, and distribution
- competitive retail power markets.

When new institutional and contractual reforms are adopted, environmental considerations are often overlooked, either because policymakers and their advisors have higher priorities or because they simply assume that reforms will automatically lead to environmental improvement.

Declining Energy Intensities

Since 1980, energy conservation and increased energy efficiency have been pushing downward the energy required to produce a unit of GDP. Among developing countries, China is a prominent example of declining energy intensity in the economy. While the economy grew on average 12 percent per year from 1980 to 1995, primary energy consumption only grew on average about 4 percent annually—an unprecedented situation for a developing country. Chinese energy consumption in 1995 would have been 2.2 times greater had the economy used energy at the same intensity as it did in 1977. This has been attributed to policies directed at energy efficiency, particularly reductions in industrial intensities. It is also the result of a concerted drive away from central planning and toward a market economy, which has raised energy prices (often within a two-tier system of coexisting state prices and market prices) and forced enterprises to consider profitability and cost minimization.

PROMISING APPROACHES

In developing countries, many promising approaches to promote energy efficiency and renewable energy have been tried over the past decade. The lessons from these programs are still emerging, but they suggest that some approaches could be expanded to larger scales and introduced in more countries.

The more promising approaches include:

- energy-efficiency labels for consumer appliances
- voluntary agreements with the private sector
- integrated market transformation
- promotion of fuel switching
- rural energy service concessions
- renewable energy portfolio standards
- rural entrepreneurship for solar PVs
- promotion of productive uses of renewable energy in rural areas
- financing and regulatory frameworks for grid-based renewable power producers.

Energy-Efficiency Labels for Consumer Appliances

Energy-efficiency labels for consumer appliances are a prominent part of efficiency strategies in Brazil, China, the Philippines, and Thailand. In China, for instance, new refrigerator standards were enacted during development of a GEF project to promote the market for high-efficiency units, and they have contributed to developing the market for more energy-efficient products.

In Thailand, the national electric utility (EGAT) has actively promoted both refrigerator and air conditioner labeling. In 1994, EGAT negotiated a voluntary refrigerator labeling scheme with manufacturers. In 1998, the labeling scheme was made mandatory, and in 1999 EGAT reached an agreement to increase energy efficiency requirements for each label by 20 percent. The program has contributed to a 21-percent reduction in overall refrigerator energy consumption. EGAT was unable to negotiate a labeling agreement with the air condi-

tioner industry, which is diverse and fragmented. Instead, it began offering both interest-free consumer loans to cover the incremental cost of high-efficiency units and rebates to shop owners who sell high-efficiency units.

Voluntary Energy Efficiency Agreements with the Private Sector

Voluntary agreements with the private sector have proven to be one of the most cost-effective approaches to promoting energy efficiency. However, such initiatives are generally limited to situations where the gains from switching to more efficient technologies are large to neutral and the switching costs are not inordinately high.

In Thailand, for example, the World Bank and GEF supported a comprehensive 5-year demand-side management program with EGAT. As part of this program, EGAT reached a voluntary agreement with all five Thai light manufacturers and one importer to switch from lower-efficiency to higher-efficiency fluorescent tubes. EGAT supported the manufacturers with an $8 million consumer information program, which explained that thin tubes give you more light for your money. In one year, the more efficient tubes increased their market share from 40 to 100 percent, so that all new tubes sold currently are higher-efficiency models.

Integrated Market Transformation Approaches

Market transformation programs attempt to alter the fundamental structure of the marketplace for specific energy-efficient products. Though still relatively uncommon in developing countries, several GEF-supported projects are promising:

- In China, a GEF/UNDP project to transform the market for energy-efficient refrigerators has just begun, but it has already influenced the market for energy-efficient refrigerators. New refrigerator standards, enacted with support from the project preparation budget, also contributed to the future market.
- In Poland, a GEF/IFC project has had a significant impact on the market for compact fluorescent lamps (CFLs). Lower CFL prices through a manufacturer subsidy, combined with a mass media campaign, resulted in sales of over 1.2 million CFLs from 1995 to 1997. The percentage of Polish households using CFLs increased from 10 to 30 percent.
- In Mexico, the national utility CFE sold 2.5 million CFLs in 2.5 years through promotional campaigns and sales through utility billing offices. Sales were higher than the 1.7 million initially targeted, and the utility has launched other CFL programs since the first program ended.

Fuel Switching

The Brazilian ethanol fuel program is a model for renewable energy development worldwide. Under the ProAlcool program, production of ethanol was stimulated through a combination of policies, including low-interest loans for the construction of ethanol distilleries, guaranteed purchase of ethanol by the state-owned oil company at a price considered adequate to provide a reasonable profit to ethanol producers, pricing of ethanol to be competitive with a gasoline-ethanol blend, and sales tax incentives during the 1980s to stimulate the purchase of ethanol vehicles.

During the first phase of the program, in the late 1970s, ethanol producers received heavily subsidized loans to finance their capital investments, and the government reached an agreement with automobile makers that led to large-scale manufacturing by 1980 of vehicles that ran on ethanol. Between 1979 and 1983, total production of ethanol more than doubled. By 1998, ethanol provided about one-third of the fuel consumed by cars and light trucks in Brazil. During 1976–96, ethanol production saved Brazil about $33 billion in oil imports (in 1996 dollars). It now supports about 700,000 jobs in rural areas at a low investment cost per worker.

From an environmental perspective, the use of ethanol has had many benefits. It reduced lead, sulfur, hydrocarbon, and carbon monoxide emissions in Brazil, while nitrogen oxide emissions remained

about the same. Ethanol fuel played a significant role in reducing urban air pollution in Brazil's large cities. In addition, the nation avoided about 13 million metric tons of carbon emissions due to ethanol substitution for gasoline in 1996–97, which is equivalent to nearly 30 percent of its actual carbon emissions from burning fossil fuels.

On the downside, however, burning sugarcane leaves and tops in the field produces air pollution, and disposal of stillage from ethanol production can pollute rivers and groundwater. Considerable attention is now being devoted to expanding uses for sugarcane and ethanol residues, including cogeneration of electricity from bagasse and leaves and production of animal feed. Recent initiatives to commercialize biomass gasification technologies can further improve the efficiency of using these wastes.

Rural Energy Service Concessions

Rural energy service concessions are private companies that provide energy services in rural markets. At present, pilot programs are under way in Argentina and South Africa. Concessions in Argentina, which operate at the province level, are free to select which technology to apply in any given situation, including diesel-only village power systems. They are obligated to provide electricity services to rural off-grid customers anywhere in the province for at least 15 years; to carry out all necessary maintenance and repairs of components; to manage connection requests, billing, collection, and claim handling; and to provide the provincial utility regulatory agency with periodic reports on the status of the concession. In return, donors provide concessions with training, technical support, and partial reimbursement for the costs of installed systems.

Renewable Portfolio Standards

Renewable portfolio standards (RPS) require that a minimum percentage of power demand in a given region or service territory be met by renewable energy sources. Usually proposed along with RPS are power trading schemes, whereby retail providers may trade their "renewable energy" generation with one another as long as all meet their respective standards.

RPS-type programs have been adopted in Denmark, Italy, the Netherlands, and the United States and are being proposed in other countries such as Japan and Portugal. Among developing countries, China and India have proposed RPS-like policies. India has suggested that 10 percent of new capacity additions through 2012 come from renewable energy, which would mean an additional 10,000 megawatts. China's latest five-year plan calls for a fivefold increase in wind power, to 1,500 megawatts by 2005. The plan also proposes to require that 5 percent of all new power generation come from renewables, which could mean an additional 20,000 megawatts by 2010. Such policies must overcome political and institutional hurdles, must fit into utility-sector restructuring, and must resolve how the extra costs of renewables (compared with conventional generation) will be allocated among utility consumers or society-at-large.

"Our objective should not be to rely on technology, but to utilize resource-efficient technology as the passageway to a low-energy infrastructure in the 21st century."

Gro Harlem Brundtland
Chair, World Commission on Environmental Development

Rural Entrepreneurship for Solar PV

Rural entrepreneurs are selling small solar home systems to rural households in several countries, notably Bangladesh, China, the Dominican Republic, Guatemala, India, Kenya, Mexico, Morocco, and Vietnam. Although many of these efforts have arisen from private-sector initiatives, in most cases government policies or programs for developing rural solar home systems markets have paved the way. Dealers typically sell systems for cash to the wealthiest rural households. In a few cases, dealers or third-party financiers extend consumer credit that improves affordability and thus allows less-wealthy rural households to purchase systems.

In Sri Lanka, several rural entrepreneurs have sold more than 5,000 solar home systems through a unique microfinance model. In this case, dealers market, sell, service, and warranty their products to rural consumers through their own local sales/service offices. Consumers obtain loans from Sarvodaya, a national microfinance institution with many local branches and strong ties to the communities in which it operates. A customer signs a credit agreement with Sarvodaya, which pays the supplier and is responsible for repayment and collections. The supplier provides maintenance service for the first 3 years, a 1-year warranty for the system, and a 10-year warranty for the PV module.

Promotion of Productive Uses of Renewable Energy in Rural Areas

Productive uses of electricity can increase incomes and provide significant social and development benefits. In turn, as incomes rise, rural populations are able to afford even more energy services. The major emerging productive uses of renewable energy are:

- *Agriculture:* water pumping, drip irrigation, crop drying, electric livestock fences
- *Health:* drinking water, vaccine refrigeration, medical/surgical equipment
- *Education:* distance education, Internet access, school lighting, computer training
- *Commercial services:* personal telephony, commercial communications, fax, Internet, photocopying
- *Small industry:* craft tools, retail lighting, sewing, grinding, freezing.

Applications in all categories are emerging, but results are still limited. Even fewer documented examples exist of good ways to raise rural incomes and extend rural social services with renewable energy. Models are still lacking that demonstrate financial, social, technical, and institutional viability in different contexts. Three emerging potential areas of focus are drinking water purification and pumping with solar PV; renewable energy that supports rural entrepreneurship, such as village mini-grids powering local industries; and "telecenters" for teacher training, distance education, distance medicine, entertainment, and commercial services.

Financing and Regulatory Frameworks for Grid-Based Renewable-Power Producers

Specific instruments for incorporating clean energy within power sector reform can be found in many countries. Brazil and India are two of the best examples.

Brazil has recently adopted several policies to promote the use of grid-connected renewable energy. Utilities are allowed to purchase renewable power at higher prices than conventional electricity, with the cost difference spread among the whole customer base. Independent power producers may supply electricity on a competitive basis to any third party, and receive open access to the transmission and distribution system based on wheeling fees. Small hydro producers receive 50-percent discounts on transmission wheeling fees.

In India, GEF support for wind power coincided with the explosive market growth of the mid-1990s, which was fueled by favorable investment tax policies, availability of commercial financing,

and a supportive regulatory framework. Transparent power purchase tariffs, transmission wheeling, third-party sales, guarantees for local utility power-purchase contracts, and power "banking" contributed to development of the market. By 2000, almost 1,200 megawatts of wind capacity had been installed in India, virtually all of it by the private sector. In addition, dozens of domestic wind turbine manufacturers had emerged, many of them joint ventures with foreign partners. Exports of turbines began, and high-technology turbine designs with variable-speed operation were being produced.

ADVANCING THE CLEAN ENERGY AGENDA

Over the next few decades, it is essential to reduce the consumption of fossil fuels through energy efficiency measures and to expand the use of renewable energy sources. To further advance the clean energy agenda, governments should:

- Adopt targets and timetables for the increased use of energy efficiency and renewable fuels
- Revise regulations and standards to facilitate markets for clean energy

- Work with multilateral agencies to enhance the environmental and social dimensions of energy-sector reform and restructuring.

Donors and multilateral assistance agencies can advance the clean energy agenda by focusing on:

- Capacity building for appropriate regulation, good policy, and sound business practices
- New financing mechanisms and institutions that can effectively channel small amounts of credit
- Transfer of technical know-how through alliances and joint ventures.

Governments, NGOs, and the private sector could create strategic alliances to promote specific clean energy and development goals. Networks of institutions also could play a greatly expanded role in information sharing, training, knowledge transfer, and monitoring progress on agreed-upon targets.

In January 2002, experts from around the world participated in a GEF Roundtable on Sustainable Energy, chaired by Professor José Goldemberg, one of the world's leading authorities on energy and development. The meeting offered a vision and set of actions to promote clean energy for sustainable development. Participants included representatives of industrial- and developing-country governments, private businesses, NGOs, and multilateral agencies.

The GEF Roundtable advanced 10 key priorities for incorporating clean energy into sustainable development in the coming years.

- *Important reductions in technology costs will arise from expanded markets in industrial countries.* Clean energy targets adopted in industrial countries mean expanded markets and reduced costs for energy efficiency and renewables, both of which benefit developing countries. Governments should adopt targets according to their respective conditions. Carefully crafted subsidies with sunset clauses should be considered.

ENERGY TARGETS FOR 2015

- Provide modern energy services to half of the 2 billion people who currently have no access to these services by 2015.
- Seek to derive 5 percent of total world energy from renewable sources by 2010.
- Improve the efficiency of—and reduce pollution from—traditional cook stoves, provide access to renewable energy for 300 million people in rural areas, and serve an additional 300 million people in developing countries with electricity from grid-connected sources.
- Provide power for 100,000 primary health care centers, 1 million water pumps, and 50,000 schools and other community services using renewable energy sources.

- *Moderating or, when possible, phasing out fossil fuel subsidies* is fundamental to improving market conditions for energy efficiency and renewable energy in all countries. Tax and subsidy policies should treat fossil fuels and renewable energy sources equally.
- *Capital is available for clean energy if new mechanisms can channel funds to those who need it,* and can divide large pools of credit into smaller increments with low transaction costs. Needs exist at three levels: households and community groups need micro-credit; entrepreneurs need long-term "patient capital" that allows them time to develop products and services based on renewable energy; and investors need reduced or shared credit risks until confidence in renewables grows and successful track records emerge.
- *Regulatory frameworks and policies can provide "market access" to renewable-energy power producers,* enabling those producers to

sell power to utilities or end-users. Such frameworks and policies can "level the playing field" for renewable energy and energy efficiency by removing inherent biases and barriers. Key elements are legal access rights and stable and fair prices. Renewable energy certificates are another policy for encouraging competitive investment and access.

- *Modern cooking fuels, such as biogas and LPG, should be rapidly integrated into development programs,* because of their health and economic benefits. Linkages to agriculture and forestry and sustainable biomass harvesting are important. The special situation of women, who spend much time gathering fuelwood and who receive the greatest exposure to indoor air pollutants, should not be neglected.
- *Integration of renewable energy into agriculture, education and health care, and rural industries* is often the least-cost option for addressing these productive and social needs without relying on purchases (and subsidies) of nonrenewable fuels. Renewable energy needs to be on the agendas of donors and officials working in these sectors.
- *Despite significant progress in improving energy efficiency, significant reductions in energy intensity—that is, reductions in energy*

BOX 4.2

RENEWABLE ENERGY: KEY TO POVERTY REDUCTION

Worldwide there are enormous disparities in people's access to clean energy. At a time when most people scarcely think twice when they flip a light switch or listen to a radio—and increasing numbers take access to the Internet for granted—two billion people live without the benefits of modern energy. Nearly half a billion people have limited or unreliable access.

According to the *World Energy Assessment*, the lack of access to clean energy directly or indirectly contributes to many of the problems of the world's poorest people. The *Assessment* concludes, "Allowing one-third of the world's population to continue to endure the constraints associated with traditional energy is unacceptable from a humanitarian and moral standpoint."

But there are many real life examples of how the availability of modern renewable energy can help reduce poverty and provide global environmental benefits. For example:

- In China, a GEF project is helping rural health clinics switch from coal-fired electricity to solar and PV systems, at 30 percent lower cost. As the health delivery expenses are reduced, clinics become more self-sufficient and can re-channel income toward improving health services. The target is to rehabilitate from 2,000 to 4,000 clinics per year in 10 provinces throughout the country. The passive solar health clinics are designed by local villagers, who also volunteer their labor for construction and maintenance.
- In Guatemala, a GEF project helped the government redefine its postwar rehabilitation program. Following a 36-year civil war that affected Maya-Quiche and Maya-Ixil indigenous communities, the government was able to provide a mini-hydropower system and PV lighting in homes in just one year. The original plan to connect the villages to a provincial electricity grid would have taken 3 to 5 years. Savings from switching to renewable energy allowed the government to set up credit lines for eco-enterprise development.
- Household solar PV systems are being promoted in more than 10 countries through GEF projects using a variety of strategies, from micro-credit schemes to loans for small entrepreneurs. The goal is to create sustainable business models that provide affordable, small amounts of high-quality electricity for lighting and other low-power needs. In Uganda, a private firm—SEAf, Incorporated—is the main contractor for a GEF-financed project to provide 840 households with solar home systems and another 2,000 households with PV-based energy. The Uganda Solar Energy Industry Association completed a technical study to expand use of solar energy, including creation of a revolving fund that would cover some of the installation costs.

Source: GEF.

use in providing goods and services—remain possible, especially in transport, buildings, and industry. Opportunities for such reductions exist even in countries with low per-capita energy use.

- *Rural entrepreneurs are key drivers of new clean-energy technologies,* particularly for household lighting and productive uses in small industry, agriculture, and water supply. But few clean-energy enterprises exist, and the challenges of rural-enterprise development and financing are large. New models of enterprise development and financing are needed, along with adoption of proven models.
- *There is a willingness to pay for "green" attributes of products and services, and such "green consumerism"* should be encouraged. Large numbers of people avoid specific products for environmental reasons and favor products certified as "green."
- *Socially and environmentally responsible investment funds* could be channeled more explicitly into meeting clean energy needs.

Taken together, these actions can make a significant difference in accelerating the trend toward clean energy and improving the availability of energy in the developing world.

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FINANCING THE ENVIRONMENT AND SUSTAINABLE DEVELOPMENT 5

Our Common Future—the report of the 1987 World Commission on Environment and Development chaired by Gro Harlem Brundtland—was a pioneering attempt to illustrate economic and environmental interdependence. It demonstrated that economic development must not only be economically and financially viable, but also socially acceptable and environmentally sound. Without one of these components, gains in national output and progress toward global sustainability are likely to be limited and ephemeral.

Historically, official development assistance (ODA) has supported economic growth and financial stability in developing countries. In the last decade, it has also supported social and human development. But financial support for the environment continues to lag, undermining the ecosystems and natural resources that billions of people—especially the poor—depend on for survival. Today, land degradation and water scarcity threaten food security and livelihoods, particularly in Africa. And, increasingly, air and water pollution are having a negative impact on human health and the productivity of natural resources.

The 1.2 billion people who live on less than $1 a day are also the most vulnerable to environmental degradation. They depend on natural resources for sustenance, and they suffer disproportionately from poor environmental conditions. Any successful strategy for addressing global poverty must address the serious degradation of the environment and natural resources.

PUBLIC OPINION AND THE ENVIRONMENT

Opinion polls are a useful starting point in evaluating public support for new and enhanced financing for environmental initiatives in developing countries. In late 2001, an international consulting firm polled 30,000 people in 30 countries, including OECD countries; developing countries in Africa, Asia, and Latin America; and eastern European and central Asian economies in transition.

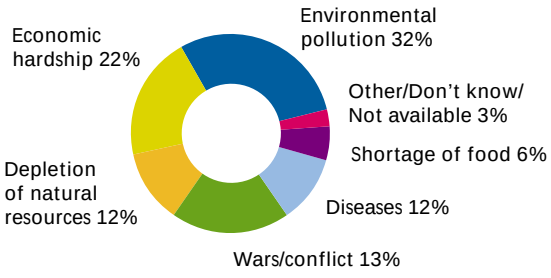
Forty-five percent of those surveyed identified natural resource degradation or environmental pollution as the single greatest threat to future generations (Figures 5.1 and 5.2). Other major threats included economic hardship (22 percent), wars and conflicts (13 percent), diseases (12 percent), and food shortages (6 percent).

The high level of public concern voiced in this survey suggests that environmental problems are adversely affecting people's lives in tangible ways. In the Philippines and Mexico, for example, more than 80 percent of the respondents affirmed that their own health was affected "a great deal" by environmental problems. The findings also indicate a high degree of awareness of environmental issues.

Although general concern about the environment seems to be high in virtually all of the countries surveyed, important differences emerged between attitudes in developed and developing countries. Respondents in countries with high per capita GDP were much more concerned with global environ-

FIGURE 5.1

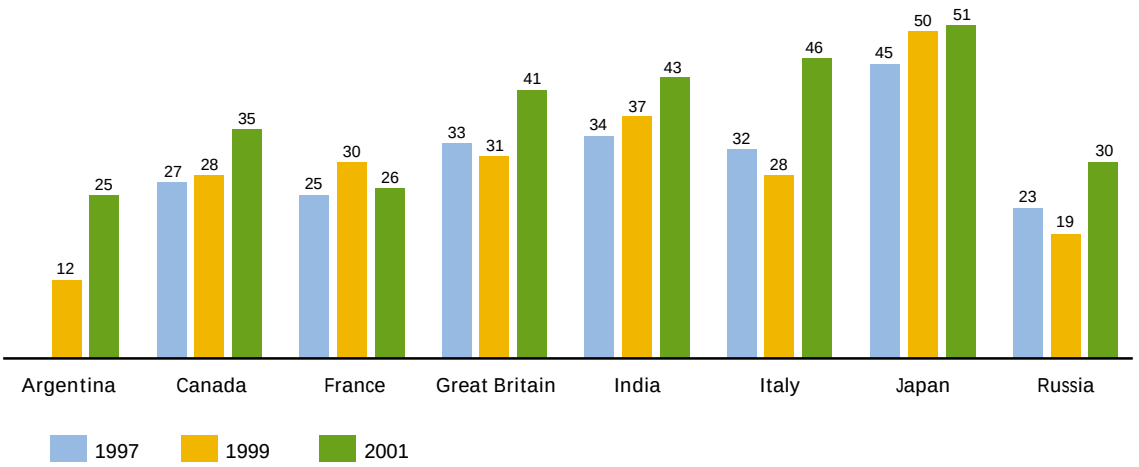
Single Greatest Threat to Future Generations



Percent of respondents is the average of G20 countries surveyed, 2001.
Source: Environics International.

FIGURE 5.2

Percent of Respondents Who Identified Environmental Pollution as Single Greatest Threat to Future Generations, 1997–2001



Note: 1997 data not available for Argentina.
Source: Environics International.

mental issues than were those in countries with low or medium per capita GDP. Those in low-income countries were relatively more concerned with local and national issues related to air and water pollution, particularly the health effects. These survey results parallel the views of scientists in a similar survey reported in UNEP's *Global Environment Outlook 2000* report.

IT'S ALL IN THE FINANCING

This high level of public concern about environmental issues provides a political foundation for generating additional financing for the environment and sustainable development. Governments, international finance institutions, and the private sector all have critical and mutually reinforcing roles to play. Financing packages must be designed to involve more than one component of this "triangle" and to foster close coordination and innovative partnerships.

Governments have the ultimate responsibility and should make the budget and policy reforms needed to promote sustainable development. For example, substantial resources could be freed, and economic efficiency improved, through the reduction or elimination of subsidies that encourage the excessive use of natural resources. A recent study of six developing countries and Russia found that fossil fuel subsidies alone amounted to some $50 billion a year. Governments can also promote sustainable development by levying environmental taxes and through initiatives that sell environmental services like the "ecomarkets" program in Costa Rica (Box 5.1). It is increasingly important for governments to foster private investment through regulatory, tax, and other reforms.

Although it accounts for a dwindling proportion of the resources flowing to developing countries, ODA continues to be essential. A greater share of ODA funds could be used to support capacity building and institutional and policy reforms at the country

BOX 5.1

COSTA RICA'S ECOMARKETS PROGRAM

With GEF support, the government of Costa Rica has developed an ecomarkets program designed to increase forest conservation. The objective is to foster biodiversity conservation and preserve important forest ecosystems through conservation easements on privately owned lands outside of national parks and biological reserves in the Mesoamerican Biological Corridor in Costa Rica.

Costa Rica's efforts to protect forest ecosystems were considerably strengthened in 1996 by the enactment of a forestry law that explicitly recognizes four environmental benefits of forest ecosystems: mitigation of greenhouse gas emissions, hydrological services, biodiversity conservation, and scenic beauty for recreation and ecotourism.

The Environmental Services Program (ESP) meets its forest conservation goals through site-specific contracts with individual small- and medium-scale farmers. Participants are required to submit a sustainable forest management plan certified by a licensed forester, and to carry out conservation or sustainable forest management activities throughout the life of individual contracts. Several types of contracts are available, including forest conservation easements, sustainable forest management, and reforestation. Forest conservation easement contracts, which pay farmers $200 per hectare over a five-year period ($40 per year per hectare), target the conservation of vegetative cover in primary and mature secondary forest areas.

Principal sources of funding for the program include a tax on fuel sales; payments to the National Forestry Financing Fund from private sector renewable energy producers, which are used for the conservation of critical watersheds; and the sale of Certified Tradable Offsets derived from greenhouse gas emissions reductions resulting from forest conservation.

Source: GEF.

level. International financial institutions, in particular, could promote greater use of innovative financial instruments such as partial risk and credit guarantees and payments for environmental services. This would leverage increasingly scarce ODA by attracting private financing for sustainable development, especially in the areas of water and energy use.

The private sector is the largest potential source of financing for sustainable development in developing countries. Attracting substantial private funding for environmentally oriented investments will, however, continue to be a major challenge because of high perceived risk. With the help of donors and international financial institutions, developing country governments can take steps to improve the general investment climate and help overcome the reluctance of private investors.

Progressive business organizations such as the World Business Council for Sustainable Development can also assist by highlighting the compatibility between sustainable development and profitability (Box 5.2). The growing emphasis on socially responsible investment, discussed later in this chapter, also has the potential to expand investments in firms that have adopted sustainable development practices.

MARSHALLING PUBLIC RESOURCES

Addressing current and emerging environmental threats will require a greater commitment from the international community in the coming decades. It is generally acknowledged that environmental initiatives are underfunded, particularly in developing countries. Donors did not live up to commitments to devote 0.7 percent of their GDPs to ODA. During the 1990s, total ODA flows stagnated in nominal terms—and actually fell in relation to the donor countries' GDPs, from 0.33 percent in 1992 to 0.22 percent in 2000 (Box 5.3). This drop undercuts the targets designated in the Millennium Development Goals.

Some recent trends, however, have been positive. One such development is that the portion of ODA allocated to global environmental initiatives has risen as a percentage of total development assistance since the 1970s. This trend is partly attributable to the role of the GEF—the only significant source of additional financing for the environment to emerge from the Rio Earth Summit. Thirty-four nations pledged $2 billion to support the GEF in 1994, 36 nations agreed to $2.75 billion in 1998, and the GEF's third replenishment in 2002 totaled $2.92 billion, the highest ever.

During the 1990s, the GEF was the major source of grant financing for environmental initiatives in its four main areas of concern: conserving biodiversity, reducing risks of climate change, preventing the degradation of international waters, and protecting the ozone layer. In its first decade, GEF's financial commitments for the environment totaled $4.2 billion, and leveraged an additional $12.4 billion in cofinancing. Although more modest in size and scope, other important funding sources for global environmental initiatives include the Multilateral Fund for the Implementation of the Montreal Protocol, which has provided resources to help countries phase out the use of ozone-depleting substances, and the G7 Pilot Program to Conserve the Brazilian Rain Forest.

Despite these impressive efforts, additional resources must be found to meet today's expanded sustainable development agenda—especially the financing of activities that address the environment. For equity reasons, these new resources should flow from developed countries. At the same time, developing countries should both continue to seek additional resources for local and national environmental problems and strengthen their own environmental laws and policy frameworks.

A number of options to enhance public sector resource mobilization have been proposed.

BOX 5.2

SUSTAINABLE DEVELOPMENT IS GOOD BUSINESS

The World Business Council for Sustainable Development has published brief descriptions of corporate experiences with sustainable development on its website. For example:

CH2M HILL. In Ukraine, the U.S.-based multinational company CH2M HILL found that citizen involvement was central to meeting the challenge of providing freshwater at an affordable price. As the old infrastructure in the region deteriorated, a new approach was required to make the transition from a centralized model to a customer-focused process in which consumers pay for services that were formerly subsidized by the government. The company's approach involved members of the local community in planning and funding new water systems—a radical concept in a newly independent nation facing complex economic and political changes.

A company with more than 50 years of experience using technology to deliver clean water and protect natural systems, CH2M HILL provided the basic equipment needed to analyze systems, and provided Ukrainian water utilities with onsite training on how to involve the public in planning and decisionmaking. The program delivers information through technical workshops on topics including water distribution, energy use, and public participation. The heart of the project in each participating city is a diverse Joint Advisory Work Group. Because the project is carried out primarily by local citizens, the process of engaging people in decisions related to infrastructure planning and funding will remain in place and ensure progress and sustainability after the company's departure.

Source: www.wbscd.ch.

BOX 5.3

TRENDS IN ODA AND FOREIGN DIRECT INVESTMENT

Official development assistance (ODA) stagnated in the 1990s. Aid flows received by developing countries fell by 3.8 percent in 2000 to $40.7 billion, and they are estimated to have declined by a further 0.4 percent in 2001 (Table 5.1). The amount of official development assistance provided by donors was estimated at 0.22 percent of developed countries' GNP, which is well below the long-accepted U.N. target of 0.7 percent.

In 2001, foreign direct investment in developing nations totaled $168.2 billion, more than four times the ODA figure (Table 5.1) and 8 percent below the peak reached in 1999.

Though foreign direct investment is large in absolute terms, it is concentrated in relatively few developing countries. In recent years, the top 10 recipients—including Brazil, China, and Mexico—received over 70 percent of total foreign direct investment in developing countries. The low-income countries received $12 billion in 2000, which was less than 2 percent of their GDP. The 47 least-developed nations received $4.5 billion. The share of foreign direct investment in low-income countries, estimated at 6.8 percent in 2000, has been roughly halved since peaking in 1996. Faster rates have occurred in developing countries such as Bangladesh, where restrictions on foreign investors have been removed.

Source: World Bank.

They include:

- Taxes on energy and CO_2 emissions
- Taxes on international travel and tourism
- Phasing out subsidies that encourage the inefficient use of natural resources.

Taxes on Energy and CO_2 Emissions. One option for raising additional funds for environmental initiatives is through the collection of new environmental taxes. Many OECD and some developing countries have instituted national taxes with environmental objectives in recent years. Revenues from environmental taxes presently account for about 2 percent of GDP in OECD countries, or about 6 percent of their total tax revenues.

Denmark, at more than 4 percent, has the highest ratio of environmental taxes to GDP. The United States, at less than 1 percent, has one of the lowest ratios. New environmental taxes have usually been accompanied by a commensurate reduction in the burden of other taxes with nonenvironmental objectives.

The transportation sector, a major contributor to greenhouse gas emissions and urban air pollution, accounts for over 90 percent of the revenue from environmental taxes. Such taxes are typically levied on the consumption of gasoline and diesel fuel, or on the sale and registration of vehicles. Denmark, Finland, Italy, the Netherlands, Norway, and Sweden have each instituted some form of carbon tax. Although these taxes vary according to the carbon content of fuels, they are generally not considered pure carbon taxes because of exemptions and rebates based on nonenvironmental considerations such as sector competitiveness or income distribution. Sweden, for example, refunds 65 percent of the carbon tax on fuels used in manufacturing, agriculture, and forestry.

An international carbon tax based on the consumption and carbon content of fossil fuels could provide a new source of funding for global environmental initiatives. There are a number of compelling argu-

ments in its favor. First, there is a clear linkage between a carbon tax and a reduction in CO_2 emissions, which closely conforms to the "polluter-pays-principle" adopted by the OECD in 1972 as the appropriate way to recover the costs of pollution. In theory, imposing this tax at high rates would discourage consumption of polluting fuels and increase the competitiveness of more environmentally benign fuels. Second, a carbon tax is clearly defined, since it is already in force in six countries. Finally, the revenue-generating potential is large even at relatively low rates of taxation. While revenue estimates vary greatly depending upon the assumptions used regarding tax rates and coverage, a recent U.N. technical note concluded that a carbon tax on gasoline applied universally—equal to 4.8 cents per U.S. gallon—has the potential to raise $125 billion a year. A U.N. High-Level Panel on Financing for Development concluded that the "international community should recognize the carbon tax as a promising possibility."

Taxes on International Travel and Tourism. The Intergovernmental Panel on Climate Change (IPCC) estimates that CO_2 emissions from aircraft accounted for 2.4 percent of total emissions from fossil fuels in 1992. The IPCC also estimates that aviation's share of greenhouse gas emissions could grow to between 3.5 and 15 percent by the year 2050.

Despite its substantial impact on climate change, international aviation is not included in international agreements on quantitative reductions of greenhouse gas emissions. Levying taxes and fees on international travel could provide incentives to reduce emissions and also help finance investments in environmental protection.

Taxes or fees on international travel, which would adhere in a general way to the polluter-pays-principle, could be assessed in a variety of ways. One simple approach would be a surcharge on all passenger tickets and air freight. The revenue-generating potential of such a tax could be substantial. It is estimated that a 1-percent tax on passenger tickets and air freight would yield approximately $2.2 billion per year—$800 million on passenger tickets alone. Similar revenues could be raised through the collection of the equivalent of $3.50 from each traveler; worldwide, tourist arrivals reached about 618 million in 1998. Such fees could be collected as a flat rate or as a percentage of a travel package.

Another potential revenue source is aviation fuel. Currently, aviation fuel used on domestic flights is seldom taxed—and fuel used on international flights is exempt from taxation. This latter exemption, based on the 1944 Chicago Convention on Civil Aviation, was originally designed to stimulate commercial aviation and to ensure fair international competition. In order to tax aviation fuel used for international flights, an international agreement would be needed, including decisions on the appropriate taxing authority. An important issue would be to mitigate the possible effects of such a tax on the economies of developing countries that rely on tourism for a significant share of their foreign exchange earnings.

An emissions-based user charge determined by the aircraft type, engine type, air route, distance, and weight is another possible approach. The International Civil Aviation Organization could play an important role in collecting an emissions-based levy, which could be used to improve energy-efficient technologies or to intensify the use of renewable energy sources.

Phasing out Resource Subsidies. In many developed and developing countries, government subsidies lower the prices of resources such as energy and water, and encourage excessive use. If large enough, subsidies can also contribute to public budget deficits and macroeconomic instability, and discourage investment by the private sector.

For example, subsidies associated with the production and sale of electricity were estimated at $112 billion per year in 1996 in developing and transitional economies. These huge subsidies encourage waste and contribute not only to local air pollution,

but to global climate change as well. Phasing out electricity subsidies could have a "win-win" effect. A reduction of 10 percent would generate annual revenues of $11 billion, reduce greenhouse gas emissions, and—as part of internationally agreed-upon emissions trading mechanisms—enable the sale of these emission reductions in the international market.

"In addition to being the right thing to do, preserving the environment is a competitive advantage and a major business opportunity."

William Clay Ford III
Chairman/CEO, Ford Motor Company

Water used for drinking, irrigation, and sanitation is also heavily subsidized in many developed and developing countries—annual water subsidies were estimated at $56 billion in 1996. These subsidies directly contribute to the overuse of water resources and are creating critical water scarcity conditions in some regions. It is estimated that 2 billion people currently face water scarcity, a figure that could double by 2025.

The World Commission on Water estimates that $100 billion more than is currently being spent on infrastructure is required each year just to meet the basic needs of people in developing countries. Since official development assistance to this sector is small, most of this financing will have to come from private sources. However, it is unlikely that the private sector will make investments of this magnitude unless national policies are changed to permit full-cost pricing of water resources (see Chapter 1). Finally, in OECD countries, agricultural subsidies amount to about $360 billion each year. Phasing out even 5 percent of these subsidies would free $18 billion for environmental and sustainable development initiatives in developing countries.

COURTING THE PRIVATE SECTOR

Increased globalization, sparked in part by the end of the Cold War and rapidly falling costs of telecommunications, gave rise to greatly expanded foreign direct investment during the 1990s. This positive development is tempered, however, by the fact that just a handful of developing countries—including Argentina, Brazil, China, Malaysia, Mexico, and Singapore—have benefited.

In 1991, foreign direct investments in developing countries totaled $124 billion. In 2001, private flows totaled $160 billion in nominal terms, a substantial decline from the peak of $341 billion in 1997, but still more than four times higher than ODA (Table 5.1). Given this reality, two key concerns are how to increase capital flows to low-income countries, particularly those that have been largely ignored by investors, and how to maximize the use of foreign investment to help solve developing countries' social and environmental problems.

Recent studies suggest that improved environmental performance and an improved bottom line for private corporations can be compatible. Several factors are strengthening linkages between profitability and environmental progress. First, partly as a result of increased pressure from shareholders and consumers in OECD countries, multinational corporations that operate in developing countries have a strong incentive to engage in environmentally sound practices. For example, an "Eco-OK" certification program for bananas was established in Costa Rica in 1993 in response to the environmental concerns of foreign consumers. Improved productivity, or "eco-efficiency," is a second factor that

TABLE 5.1

Trends in Resource Flows to Developing Countries, 1991–2001 (in billions of U.S. dollars)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000[a]	2001[b]
Net long-term resource flows	124.2	153.7	220.9	222.4	260.2	306.6	341.4	336.7	271.8	261.1	196.5
Official flows	62.2	54.3	53.4	46.0	54.1	30.3	40.7	53.4	47.4	35.3	36.5
Foreign direct investment	35.7	47.1	66.6	90.0	106.8	130.8	172.5	178.3	184.4	166.7	168.2

a. Preliminary b. Estimate
Source: World Bank.

leads to beneficial environmental outcomes. The privatization of Mexico's steel concern, AHMSA, for example, has led to reduced emissions into the air, the elimination of acidic wastewater discharges, and increased rates of recycling.

Commercial banks, governments, multilateral agencies, and company managers are sensitive to environmental impacts when making financial decisions. Commercial banks, for example, now often require that private sector investments in major projects follow World Bank environmental guidelines or the equivalent. However, many environmentally friendly projects in developing countries have difficulty attracting long-term capital. This is due to a host of factors, including the modest size of most businesses in these countries; traditional lenders' lack of familiarity with activities such as organic agriculture, sustainable forestry, and ecotourism; and the relatively higher risk involved.

In recent years, the availability of long-term financing for environmentally oriented projects has improved. Water and wastewater treatment, renewable energy, and natural foods are now of interest to some venture capitalists. For example, the Environmental Enterprises Assistance Fund, a $10 million nonprofit fund that focuses on Central America, has over the past few years made more than 25 investments in renewable energy, organic agriculture, environmental technologies, and forestry. The GEF/IFC Terra Capital Fund provides financing for biodiversity-related private investments in Latin America; other investors include the Swiss government and private sources. And the IFC and GEF are collaborating to provide financing for small and medium enterprises that work to conserve biodiversity and mitigate climate change. If these initiatives can demonstrate the long-term financial viability of small- and medium-size environmental projects, it will encourage traditional commercial sources to support similar enterprises.

Another important development is the growing public support for socially responsible investments, which enable investors to direct their savings into firms that engage in ethical and sustainable production and marketing. This investment approach originated in North America and Europe in the 1970s and expanded rapidly after firms adhering to sustainable development values proved, on the whole, to be more profitable than those that did not.

At present, global funds that endorse socially responsible investments are managing $1.4 trillion in assets. Most of these funds are invested in developed countries, and the direct impact on developing countries has been limited. But this may change in the future. For example, when a transnational corporation is being considered as an investment opportunity, fund managers now look at the social and environmental practices of the corporation's

subsidiaries in developing countries—creating an incentive for firms to improve their environmental and social performance.

THE VALUE OF DEBT-FOR-NATURE SWAPS

Debt-for-nature swaps are voluntary transactions in which a portion of a developing country's hard-currency debt is canceled or reduced by a creditor. In exchange, the debtor agrees to allocate a portion of its cancelled debt in local currency to environmental programs or projects. Initially, most were private swaps in which international environmental NGOs raised the funds and initiated the process. In recent years, many swaps have been bilateral, where both the creditor and debtor are governments. Other creditors can include commercial banks or commercial firms owed money by governments of developing countries. In practice, debt-for-nature swaps can be highly complicated and frequently require experienced environmental NGOs to negotiate the agreements. Successful debt-for-nature swaps can bring multiple benefits: creditors can be relieved of an asset that might never be repaid in full, and debtors can reduce their external debt burdens without drawing down scarce foreign reserves and may even gain considerable debt relief.

Conservation International brokered the first debt-for-nature swap in Bolivia in 1987; $650,000 in debt was canceled in return for the implementation of certain conservation measures in the country. Other swaps followed that same year in Costa Rica and Ecuador. Since 1987, over $1 billion in funding has been generated by debt-for-nature swaps in

nearly 30 countries. Bilateral swaps typically allow developing country governments to reduce their debt obligations in part through buy-backs at discounted prices, or in full through debt forgiveness. The converted debt is usually deposited—in the form of local currency-denominated government bonds—in a conservation trust fund that disperses the funds (derived from interest and amortization of the bonds) for agreed-upon conservation purposes.

To date, only a few developed countries—Canada, Finland, Germany, the Netherlands, Switzerland, and the United States—have used bilateral debt-for-nature swaps. The most significant is the U.S.-sponsored Enterprise for the Americas Initiative established in 1990. The program provides for a reduction in debt owed to the U.S. government and allows interest payments in local currency to be applied to local environmental programs and projects. To date, Argentina, Bolivia, Chile, Colombia, El Salvador, Jamaica, and Uruguay have participated. The initiative has provided $876 million in debt relief, plus $154 million in local donations. The Americas Initiative was reinforced in 1998 through the U.S. Tropical Forest Conservation Act, which promotes debt relief in exchange for local currency funding of tropical forest conservation. The U.S. government has budgeted $225 million for this program during 2002–04.

Developing countries' external debt reached approximately $2 trillion in 2000. In many countries, servicing external debt is a major constraint to financing sustainable development programs, including environmental initiatives. The international donor community has responded to this issue by sharply ratcheting up debt relief measures. The Heavily Indebted Poor Countries (HIPC) Initiative proposed by the World Bank and the IMF in 1996 is the most ambitious and comprehensive of these measures. The Initiative targets developing countries with the most unsustainable debts. In the 26 countries that are participating, most in Sub-Saharan Africa, overall annual debt service paid during 2001-05 is expected to be cut by about 30 percent relative to actual annual debt service payments made in 1998-99.

The HIPC Initiative requires countries receiving debt relief to increase social spending as part of their poverty alleviation efforts. If environmental spending were included, debt relief could be used to encourage increased government spending on labor-intensive environmental programs such as reforestation and soil conservation. Such programs generate income and promote economic growth, reinforcing the links between poverty alleviation and the environment.

THE CASE FOR VOLUNTARY "GREEN" PAYMENTS

Bolstered in part by surveys showing strong public support, many governments and private companies have adopted voluntary payment systems to finance environmental initiatives. Utility companies, for example, use "green pricing" to encourage greater use of renewable energy sources. In addition, some U.S. state governments allow taxpayers to contribute to various environmental causes by checking boxes on their tax forms. BP Amoco's Global Choice program is linked to the introduction of a new type of gasoline that is being marketed as a highly refined, low-emissions product in Australia. When a motorist fills a gasoline tank with this new brand of fuel, BP Australia agrees to invest a percentage of the purchase price in environmental projects—for example, renewable energy, new forests, innovative technology—designed to offset greenhouse gas emissions. All such activities are certified by the government and are independently verified.

Since automobiles are major contributors to greenhouse gas emissions and urban air pollution, it would be environmentally beneficial to link green payments to new car sales or annual registrations. Available estimates suggest that over the 100,000-mile useful lifetime of an automobile, total carbon emissions are around 10 tons for a 35-mile per gallon car and 20 tons for a 20-mile per gallon car. If the costs of remedial action to offset these emissions are assumed to be a conservative $10 per ton

of carbon, each new owner of a 20-mile per gallon vehicle could be asked to contribute a maximum of $200 for the environment. Specific contributions could vary according to a vehicle's fuel economy and emissions.

If only 10 percent of new-car buyers in the United States each voluntarily agreed to contribute $200, annual receipts would be on the order of $200 million. If the same assumptions were applied to Japan and other OECD countries, this sum would roughly double. If owners of *all* motor vehicles, not just new ones, were asked to make voluntary green contributions, the potential for revenue generation would be much greater. For example, assuming a 100-percent participation rate, a $1 green contribution added to annual car and truck vehicle registration fees in OECD countries would generate about $500 million per year.

The prospect of low participation rates raises questions about whether voluntary schemes conform to the polluter-pays principle and to ethical concerns about fairness. Many potential contributors may not wish to give a "free ride" to those who choose not to contribute. A survey on green pricing carried out in Germany, for example, found that many customers thought mandatory premiums were more equitable than voluntary contributions. Potential contributors would also have to be convinced that revenues generated through voluntary contributions were being applied efficiently and effectively in worthy environmental projects. Such programs would require a simple and highly transparent administrative structure.

The support of major automobile manufacturers and retailers is, of course, essential to the success of any program of voluntary contributions based on new-car sales. And in the case of the proposed $1 voluntary contribution linked to the collection of annual vehicle registration fees, the cooperation of governments would be required as well.

Demonstrating environmental leadership is becoming a shrewd business decision. Automobile dealers, for example, could offer participating customers "green certificates" or some other symbol of environmental commitment. To encourage customers to contribute at the time of purchase, dealers might also solicit contributions in lieu of low-interest financing options or "cash back" programs.

THE BOTTOM LINE

Sustainable development is one of the most urgent challenges now facing humankind. In order to reverse negative environmental trends, the world community must mobilize additional financial resources.

Public-private partnerships can achieve objectives that individual parties cannot achieve alone. While governments must continue to exert leadership, there is much to be gained from forging partnerships to promote sustainable development among the public and private sectors, local and national governments, national and international agencies, NGOs, and civil society.

Partnerships can leverage public sector financing, and innovative financing can often be best promoted through public-private partnerships. Development assistance can catalyze other sources of financing, build capacity, strengthen institutions, share risks, and reduce transaction costs for private investment.

As this chapter shows, there are many options for innovative and creative approaches to financing sustainable development. But the world community must find the ingenuity and political will to adopt mechanisms that will mobilize the financial resources needed to move the agenda forward.

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CONCLUSION

Not long ago, tackling environmental problems was viewed as simply banning a toxic chemical or establishing a protected area or national park. The growing demand for ecosystem services—more timber, agricultural land, or freshwater—was met by tapping unexploited resources.

But today's challenges—and those looming on the horizon—are complicated by many variables that interact in complex and often misunderstood ways, making successful solutions more difficult. The magnitude of human demands on fragile ecosystems has reached the point where tradeoffs among goods and services have become the rule. Caught in the middle are decisionmakers in government, communities, and the private sector who are sometimes forced to make important resource decisions without an adequate understanding of the effects their choices will have.

In addition, peace and stability have eluded a number of developing countries because the root causes of people's suffering have been ignored.

Environmental degradation, poor economic policies, and the population explosion have pushed millions of people into cities that are unprepared for them—and into ways of life for which they are unprepared. For many young people, there is little hope. A lack of education, training, and job opportunities can ignite their discontent and lead to extremism, crime, and even terrorism. Providing hope for *all* citizens, not just certain segments of society, will require a comprehensive program of economic development and environmental protection and rehabilitation.

One of the critical outcomes to emerge from the 1992 Rio Earth Summit was a commitment by the international community to integrate environmental and development issues so that global sustainability could be ensured. Agenda 21 was the global action plan for sustainable development that was adopted at that historic meeting. Agenda 21 asserts that "Human beings are at the center of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature."

In the 10 years since the Rio Summit, progress toward sustainability and poverty alleviation has been unacceptably slow. To address this lag, world leaders gathered at the U.N. Millenium Summit in New York in 2000 unanimously endorsed the Millennium Development Goals, a set of ambitious targets to improve the quality of life for all people on our planet. Specifically, the aim is to halve the proportion of the world's people who live in extreme poverty by 2015, and to provide education, improve health, and preserve the environment for current and future generations.

As we look ahead, the next decade presents a unique opportunity to ensure that environmental sustainability is fully and effectively integrated into actions designed to achieve the Millennium Development Goals. The challenge is to ensure that development for all people is pursued within a framework of long-term sustainability. A partnership for global sustainability that lifts future generations from poverty and eliminates the threat of living on an irredeemably spoiled planet is within our reach.

ENSURING A SUSTAINABLE FUTURE

The preceding chapters provide dozens of successful examples of sustainable development initiatives that are models for the future. They address key elements for meeting the challenge of global sustainability:

- Phasing out subsidies that encourage economic inefficiency and the excessive use of natural resources
- Creating business environments and public policies that attract more foreign direct investment by private firms
- Creating conditions that foster socially responsible investments in developing countries
- Promoting public-private partnerships that fully integrate long-term sustainability into poverty eradication and economic development
- Mobilizing additional financial resources for environmental improvement
- Removing barriers in developed countries to imports from developing countries, particularly in the agricultural sector
- Strengthening institutional capacity and policies to protect the environment and support sustainable development
- Implementing commitments by all countries—developed and developing—to international environmental agreements
- Expanding and replicating successful pilot programs, experimental projects, and innovative policies
- Setting clear goals, targets, and means for monitoring progress toward achieving them.

The preceding chapters also highlight how each of these strategies contributes to the achievement of the Millennium Development Goals. Despite the problems we face, there are promising and positive trends that we can build upon:

- Clean renewable fuels are now the world's fastest-growing energy technologies. They still represent only 2 percent of the world's energy consumption, but the use of wind and solar power is increasing from 20 to 40 percent each year.
- More countries are devolving control of their forest resources to local communities and indigenous groups, providing unique opportunities for sound and sustainable forest management.
- There is growing awareness that ignoring the environmental effects of agriculture complicates the already difficult challenge of increasing food production to feed a growing global population.

These trends are promising. But progress toward global sustainability and attaining the Millennium Development Goals will require removing the following major constraints and barriers:

Lack of appreciation for and recognition of the environment as natural capital and as the foundation of social and economic systems, which hinders large-scale investment in global sustainability. Forests, for example, are primarily valued as timber, not for providing habitats for biodiversity and other genetic resources, regulating the climate and the flow of water, protecting soils, and offering beautiful landscapes and opportunities for ecotourism.

Lack of international cooperation on the management of natural resources found in cross-boundary areas such as a watershed or global commons, providing little incentive for individual countries to be concerned with the consequences of their actions. One of the important lessons gleaned from the depletion of the ozone layer

was the absolute necessity of concerted global action and international agreements to protect the global commons.

Continued support for sector-by-sector programs on the part of national and international agencies—despite the clear cross-sectoral impacts—leading to conflicting uses of resources. Responsibility for the environment and development is often vested in discrete government ministries or fragmented among rival communities and enterprises, which hampers integrated responses at the appropriate scale.

Inadequate and misdirected finance, weak supporting institutions, and inappropriate policies, which interfere with progress in managing resources and ecosystems. At a time of increasingly scarce official development assistance, it is ironic that—not taking into account the war on terrorism following September 11, 2001—global military spending in 2001 totaled $839 billion, or 2.6 percent of gross domestic product worldwide, about $137 per person. Poor countries like India and Pakistan rank fifth and tenth, respectively, in world arms imports over the last five years, purchasing supplies worth $4.71 billion and $2.93 billion.

Lack of capacity, knowledge, and skills in a developing country, which can be a barrier to the adoption of new technologies or sustainable management of natural resources. Many developing countries, for example, do not have the scientific and institutional capacity to understand the consequences of climate change and the means for mitigating, or adapting to, its deleterious effects.

The cost of clean technologies, which can act as a barrier to the promotion of such technologies. Lack of adequate financing, particularly in rural areas and among low-income populations, can hinder the dissemination of environmentally friendly technologies.

Addressing these constraints could provide developing countries, especially the least developed, with the tools and mechanisms needed for sustainable development. In addition, setting global targets and goals helps to promote and focus action, allowing for the measurement of progress and fostering international cooperation and coordination. But national targets, goals, and policies are better able to take into account country-specific needs and situations. It is also important to establish mechanisms to monitor and measure implementation of such targets, goals, and policies.

THE MILLENNIUM DEVELOPMENT GOALS

- Eradicate extreme poverty and hunger
- Achieve universal primary education
- Promote gender equality and empower women
- Reduce child mortality
- Improve maternal health
- Ensure environmental sustainability
- Combat HIV/AIDS, malaria, and other diseases
- Develop global partnerships for development

TAPPING THE FULL POTENTIAL OF FINANCIAL PARTNERSHIPS

A key barrier to international cooperation on the global environment and sustainable development is the availability of adequate financing. In order to maximize outcomes, it is important to design finance packages that include input from governments, external public assistance, the private sector, and civil society.

The GEF, for example, facilitates a variety of sustainable and replicable financing mechanisms that pro-

mote renewable energy by assisting both small households and large power producers.

In collaboration with GEF and commercial banks, NGOs in Sri Lanka, Bangladesh, and Vietnam are serving as community-based microfinance offices. These offices channel credit financing to small dealers in household energy systems, creating a financing infrastructure that will be sustainable after the GEF project is completed.

For power generation projects like India's, where independent power producers contract with local communities and firms for power service, GEF provides commercial credit guarantees, facilitates policies that encourage private investment, and helps build the confidence financiers need to invest in renewable energy projects. By "mainstreaming" the financing of renewable energy technologies among public and private investors and lenders, GEF helps to sustain industry growth beyond one-time projects and in turn accelerate reductions of greenhouse gas emissions.

Promoting sustainable development must become a greater priority for governments. And by pooling resources and political will they can mobilize behind winning environmental strategies. Governments can and should make the budget allocations and policy reforms that are necessary to support sustainable development. They can free substantial resources, and improve economic efficiency through the reduction or elimination of subsidies that encourage the excessive use of natural resources, particularly water and energy. A key role for governments is the creation of enabling environments for private investment—through regulatory reforms, and by making domestic capital more readily available for investments in sustainable development.

Donors should increase public external assistance for both capacity building and institutional and policy reforms at the country level, because external resources can play an important role in leveraging private financing of sustainable development. Private businesses are often best positioned to support successful investments in the areas of water, sanitation, and energy. Greater use of innovative financial instruments, such as partial risk and credit guarantees and payment for environmental services, should also be promoted.

Civil society's financial contributions, including those of individuals and local communities, should be recognized and harnessed in support of sustainable development. Through socially responsible investments, people in both developed and developing countries can invest in firms that follow sustainable development practices. And better mechanisms should be developed to tap into the interest of individuals who choose to invest in an environmentally sustainable future.

Although governments must continue to take the lead in promoting sustainable development, there is much to be gained from the formation of partnerships among the public and private sectors, various government entities, national and international agencies, NGOs, and private citizens. But to reap the full benefit of those partnerships, a comprehensive policy framework should be developed with the goal of achieving specified outcomes.

GEF is a novel, multilateral entity that engages in an array of partnerships of varying dimensions and builds upon the comparative strengths of its partners. One partnership is between developed and developing countries working to achieve global environmental benefits.

GEF has also forged partnerships with its three implementing agencies—UNDP, UNEP, and the World Bank—and this level of partnership is growing to include other organizations. Finally, NGOs have had an unprecedented role in the GEF; currently more than 700 NGOs participate in GEF activities as co-executing agents or service contractors—more than three-quarters of them in developing countries.

IT WILL TAKE ALL OF OUR WILL AND INGENUITY

So, what will it take to protect our biological heritage, avoid the devastation that climate change could bring, sustain the soil and water that give us life, protect human health, and reduce the scourge of poverty and hunger? It will take leaders from all walks of life who are willing to think and act differently and lead the way. And we must all internalize the lessons learned and replicate our successes. Most importantly, we must build on what we have learned in the past.

- We must share the benefits of new knowledge and opportunities by utilizing environmentally friendly technologies and approaches.
- We must move beyond traditional financial formulas and restraints to cultivate new financial resources—ones that will allow greater cooperation and investment in global sustainability.
- We must foster better understanding of the potential that lies in our natural world, its people, and other living things.
- We must make polluters pay, but we can also go further by building sustainable livelihoods and facilitating joint ventures.
- We must move beyond corporate greed and "irresponsibility," and use pressure from governments, investors, and consumers to advance corporate citizenship, self-regulation, and the business case for sustainability.
- We must use advances in science and technology to shape the future and confront the challenges of the twenty-first century.

The central message of this book is one of hope, and of new strength and determination. In many ways, we have entered one of the most creative phases in human history, where science, technology, and communications advance at breathtaking speed and offer unmatched opportunities for political consensus and responsible change. We have new tools at our disposal, and a vastly increased understanding that our strength lies in working together to overcome the threats facing our planet. The actions we take and investments we make in the decades ahead will determine both our own evolution and that of future generations.

Our fates are intertwined. We owe it to each other, and to our children and their children, to combine forces and ensure a sustainable future on earth.

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THE HUMAN COMMUNITY FACES AN ARRAY OF CHOICES ABOUT THE QUALITY OF OUR LIVES AND THE STATE OF THE GLOBAL ENVIRONMENT. EACH OF THOSE CHOICES WILL HELP TO DETERMINE WHAT KIND OF WORLD OUR CHILDREN AND GRANDCHILDREN WILL LIVE IN . . . THE LEGACY IS LARGELY OURS TO SHAPE.

KOFI ANNAN

U.N. SECRETARY GENERAL

GLOBAL
ENVIRONMENT
FACILITY

ABOUT THE CHALLENGE OF SUSTAINABILITY

IN MANY WAYS, WE HAVE ENTERED ONE OF THE MOST CREATIVE PHASES IN HUMAN HISTORY, WHERE SCIENCE, TECHNOLOGY, AND COMMUNICATIONS ADVANCE AT BREATHTAKING SPEED AND OFFER UNMATCHED OPPORTUNITIES FOR POLITICAL CONSENSUS AND RESPONSIBLE CHANGE. WE HAVE NEW TOOLS AT OUR DISPOSAL, AND A VASTLY INCREASED UNDERSTANDING THAT OUR STRENGTH LIES IN WORKING TOGETHER TO OVERCOME THE THREATS FACING OUR PLANET. THE ACTIONS WE TAKE AND INVESTMENTS WE MAKE IN THE DECADES AHEAD WILL DETERMINE BOTH OUR OWN EVOLUTION AND THAT OF FUTURE GENERATIONS.

OUR FATES ARE INTERTWINED. WE OWE IT TO EACH OTHER, AND TO OUR CHILDREN AND THEIR CHILDREN, TO COMBINE FORCES AND ENSURE A SUSTAINABLE FUTURE ON EARTH.

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