

the  
Global Environment

18248  
1998

Actions & Investments  
for a 21st Century



WORLDWIDE  
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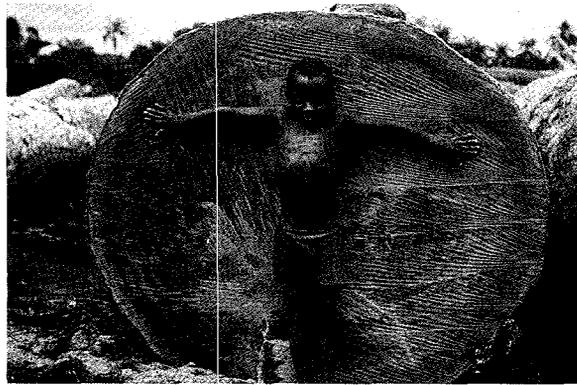
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# VALUING

the Global Environment



Actions & Investments  
for a 21st Century



Global Environment Facility  
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# VALUING THE GLOBAL ENVIRONMENT

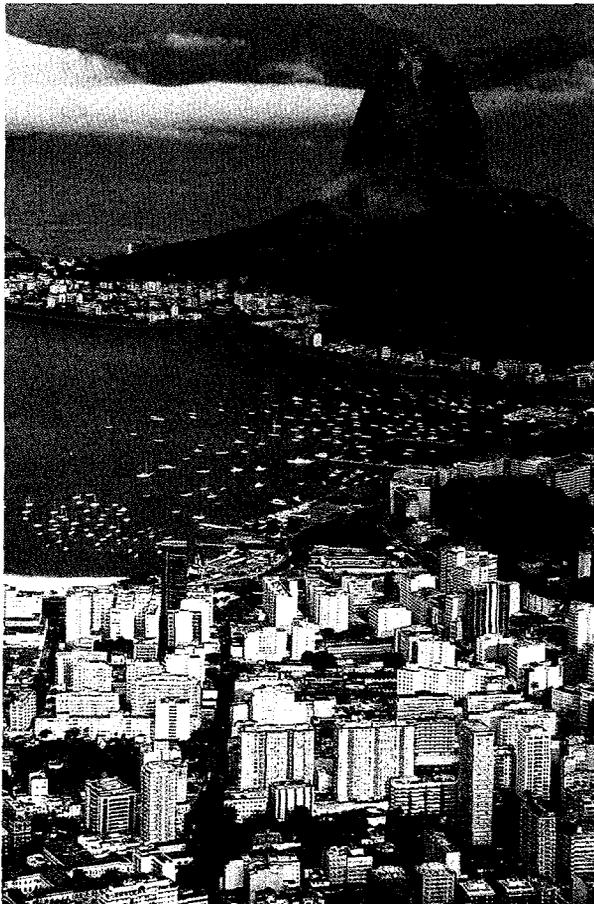
## Actions & Investments for a 21st Century

### Foreword by

FERNANDO HENRIQUE CARDOSO

President of Brazil

In 1992, leaders from all over the world gathered in Rio de Janeiro for the United Nations Conference on Environment and Development and established sustainable development as a new paradigm that would ultimately deal not only with global environmental challenges, but also with the very social fabric of nations, and thus have a positive and direct impact on the life of individuals everywhere.



An unprecedented era of environmental awareness was heralded. The world seemed ready for a new model of civilization, one in which global problems would be addressed globally and unsustainable patterns of production and consumption, so conspicuously followed in the past, would at last make room for a more rational and integrated relation between, precisely, environment and development.

We have, over the years, managed to bring the issues of environment and development to the top of the international agenda. Gradually, our countries have been incorporating sustainability as a major concern into their macro-economic planning.

No one could dispute the fact that much remains to be done; we need to work swiftly and decisively if we are to confront the problems that affect our planet's life supporting systems. We have to avoid repeating past errors, both domestically and internationally.

The recognition of the indissoluble bond between environment and development brought home the need to forge a new global partnership between developed and developing countries. Globalization must therefore usher in a new sense of solidarity, for poverty and underdevelopment are powerful causes of environmental degradation. We must carry on along the road that leads to a new mode of modernization. The international community must continue to build an enduring consensus with respect to issues on the global environmental agenda. And this must be carried out on the basis of the common, but differentiated, responsibilities of its members.

A major breakthrough in this direction was achieved in Kyoto, in December of 1997, when governments finally agreed to move ahead in fulfilling their commitments under the United Nations Framework Convention on Climate Change. More importantly, the parties to the Convention agreed to establish a "Clean Development Mechanism", an innovative market instrument unlike any other international funding system, which will help to meet these commitments and foster investments in environmentally sound technologies in developing countries.

As we look into the future of our planet at the dawning of a new century, we can only hope that out of an increasing awareness, wisdom and a sense of urgency will develop, and that both the public and the private sectors will stand up to their responsibility in the advancement of sustainable development for the benefit of generations to come.

At this point, it is essential that discussions on environment and development should get on board as many representative sectors of society as possible, in order for people with a direct stake in environmental challenges to have a direct say on how best to face them.

By bringing together contributions from a number of people with large experience on both ends of the environmental issues – theory and practice – this book, made possible by the Global Environment Facility, will provide the reader with valuable insight, thus contributing to the broadening of a well-informed and action-oriented debate on sustainable development, a timely and most welcome effect.



Introduction to

# Valuing the Global Environment: Actions & Investments for a 21st Century

Earlier this year I had the joy of becoming a grandfather for the first time. In April, I will have the honor of joining colleagues from 161 nations in the Global Environment Facility's first Assembly in New Delhi. These milestones have more to do with each other, and with this book, than might at first seem apparent.

Join with me in asking yourself these questions:

What urgent environmental problems overshadow all children born into the world today?

What combination of economic and environmental challenges can the generation coming of age in 2020, and those to follow, expect to tackle?

What new partnerships, policies, and finance are needed now to ensure their success?

As last year drew to a close, people the world over gained a deeper appreciation of our economic and environmental interdependence. Starting in Asia's newly industrialized nations, falling stock markets followed the sun, producing record declines in Japan, Europe, and the Americas. In Southeast



Asia, during the same period, forest fires raged for weeks, spreading smoke across six countries and adversely affecting the health of more than 70 million people. And in Kyoto, negotiators worked into the early morning hours to forge a consensus on Earth's climate future.

Interdependence means that all of us, whatever the stage of our development, are traveling in the same boat, floating and sinking together. Building a sturdier vessel benefits all passengers. The vocabulary of interdependence does not recognize winners and losers, nor does it dwell on the "burdens" of international engagement. Opportunity sharing is what we must now be about.

## Part I: Signals on the Horizon

Most of our current development choices, North and South, are rocking the boat. As chapter one illustrates, the gap between rich and poor – between and within nations – is widening. Consumption and population trends alike spell serious trouble, and environmental issues, like the economy itself, are increasingly global in nature. Ecosystems critical to the functioning of earth's life support systems continue to be undermined, and land degradation threatens food security and livelihoods.

How much better off all of Earth's people will be when we adopt and implement sustainable development as our common endeavor – and that can and will happen with the active support of citizens everywhere. Chapter two highlights the ongoing efforts of environmental advocates and entrepreneurs to build constituencies for change. These courageous many are enabling governments and international institutions to alter the political economy of environmental degradation from the bottom up, with the active assistance of non-governmental organizations and other community based groups.

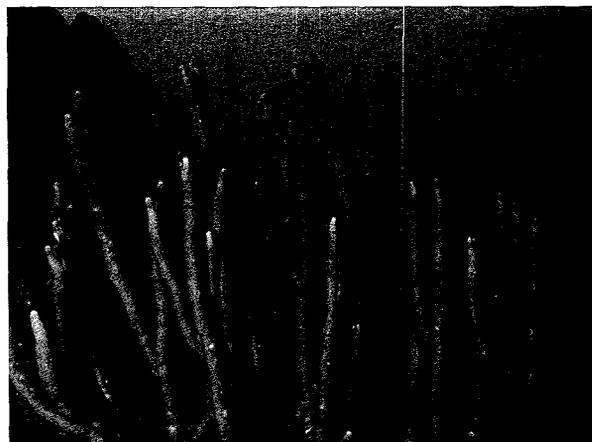
During the last decade, these new partnerships have led us to a common understanding of the

most fundamental priorities facing all nations. Reducing the risks of climate change, conserving and sustainably using our stocks of biological diversity, protecting international waters, phasing out ozone-depleting substances – and associated efforts to combat land degradation – these are issues encompassing the fate of all peoples, political systems, sectors, species, and generations. They are problems which must be solved together and soon. What is more, and often forgotten, is that these solutions hold enormous promise for alleviating poverty and improving quality of life for all.

Any strategy that aims to sustainably manage earth's resources must build on the positive ties between development and the environment, while breaking the negative bonds between economic growth and environmental degradation. "Business as usual" can give way to alternative scenarios with positive outcomes for all. But first we must incorporate environmental values into all our priorities and actions. This includes repositioning our economies – not necessarily toward producing less, but definitely toward producing (and consuming) differently.

Efficiency, innovation, substitution, and structural change. Together, these principles can have a powerful effect on the relationship between economic activity and the environment by ensuring that the scarcity of natural resources is accurately reflected in the value societies place upon them. Firms of all sizes have little reason to cut back on wastes and emissions, until the right incentives – provided by regulations, charges, inducements, or other means – are established. Given fragile and limited resources, poorly defined or non-existent property rights, limited access to credit and insurance markets, and the simple need to survive, low income producers – a majority of the world's people – are generally unable to invest in long-term environmental protection and resource conservation.

Chapter three describes market-based policies governments can apply to accelerate the transition to sustainable development. Key measures include



new incentive systems, the elimination or reduction of price subsidies, the clarification of property rights, and, at the national level, more open trade and investment policies which promote the adoption of environmentally friendly technology and a more efficient allocation of resources. No single approach works everywhere and all entail costs – financial, political, or both. But the benefits can be great and this much is certain: the costs of inaction to human health and welfare and to our natural environment will prove much greater over the long term.

## Part II: Four Issues for the Next Century

**Biodiversity loss.** Extinction and ecosystem destruction threaten earth's vital life support system. By adopting new strategies for conserving and sustainably using biodiversity, we will preserve not just the many "free" economic benefits we take for granted (agriculture, pharmaceuticals, the raw components of our material civilization), but also the cultural, spiritual, and purely biological values inherent in our natural world.

**Climate change.** Melting ice caps and the thermal expansion of the oceans are of immediate concern to residents of low-lying island states and coastal areas. In time, greenhouse gas-induced climate change threatens to play havoc with most everyone's weather, disrupt agricultural trade, deal a strong blow to already weakened ecosystems

(forests, wetlands, and coral reefs), and give new impetus to the spread of infectious diseases. New policy and technology approaches offer opportunities for reducing greenhouse gas emissions while putting our energy future on a sustainable footing.

**International waters.** The local water problems of the 1970s have become the transboundary problems of the 1990s, linking the global water cycle to urbanization, industrialization, watershed degradation, deforestation, biodiversity loss, and climate change. The human interrelationships are equally complex, involving geopolitical concerns, regional and global markets, monetary policies, and in-country subsidies. By scaling up lessons learned in transboundary waters management and partnerships, we can weave a safety net for the billions of people living in coastal communities and multi-country river basins.

**Ozone.** By initiating the phase-out of ozone-depleting chemicals during the 1970s, we are already experiencing a lower incidence of skin cancers than scientists originally predicted. Enforcement efforts continue but it is clear that lessons and the momentum gained from this success can help to carry us forward on other fronts as well.

Prevention and control of land degradation, especially desertification and deforestation, are critical to achieving sustainable development at the national level. They are also central to global environmental progress. The environmental and economic consequences of land degradation are not confined to the countries where it occurs. Its effects – loss of biodiversity, reduced atmospheric and subterranean carbon sequestration, and pollution of international waters – can be significant and global.

As part of its mandate, the GEF has endeavored to address land degradation as it relates to biodiversity, climate change, and international waters. Countries are taking a variety of actions to stop it. These include improved farming and grazing practices; afforestation, reforestation, and forest management; upgraded water management; and institu-

tional and policy reform for better land use policies.

Chapters four through seven provide a comprehensive frame of reference for considering all of these global problems and their solutions: current scientific evidence, the power of grassroots action, the evolving policy response, a balance sheet of costs and benefits of action and inaction, and a short guide to the most promising new collaborative solutions on the horizon.

Finally, the book's epilogue – "Getting There from Here" – speaks to opportunities for global environmentalism around the world, and the role of the Global Environment Facility (GEF).

GEF produced *Valuing the Global Environment* in time to coincide with its first Assembly for a number of reasons, including to provide a common background for the meeting itself. The book's ideas, and a number of its examples, draw on the GEF's experience working in 119 nations since 1991. But to an even greater extent, this book reflects the innovation and hard work of millions of individuals and institutions worldwide over the last few decades – and we are indebted to President Cardoso and over two dozen guest essayists from more than 20 nations for sharing their personal insights and professional recommendations.

Never has the time for international cooperation to every nation's individual benefit been more ripe. Earth's 21st century can provide answers to many of the questions that plague us in the 20th. We can be agents of positive thinking, while making clear the risks of business as usual. We can be the catalyst for partnerships, while recognizing the challenges of forging consensus. As the new millennium approaches, with the support and involvement of the community of nations, the GEF will continue to look for new opportunities to add value to and for the global environment.

Mohamed T. El-Ashry  
CEO & Chairman  
Global Environment Facility



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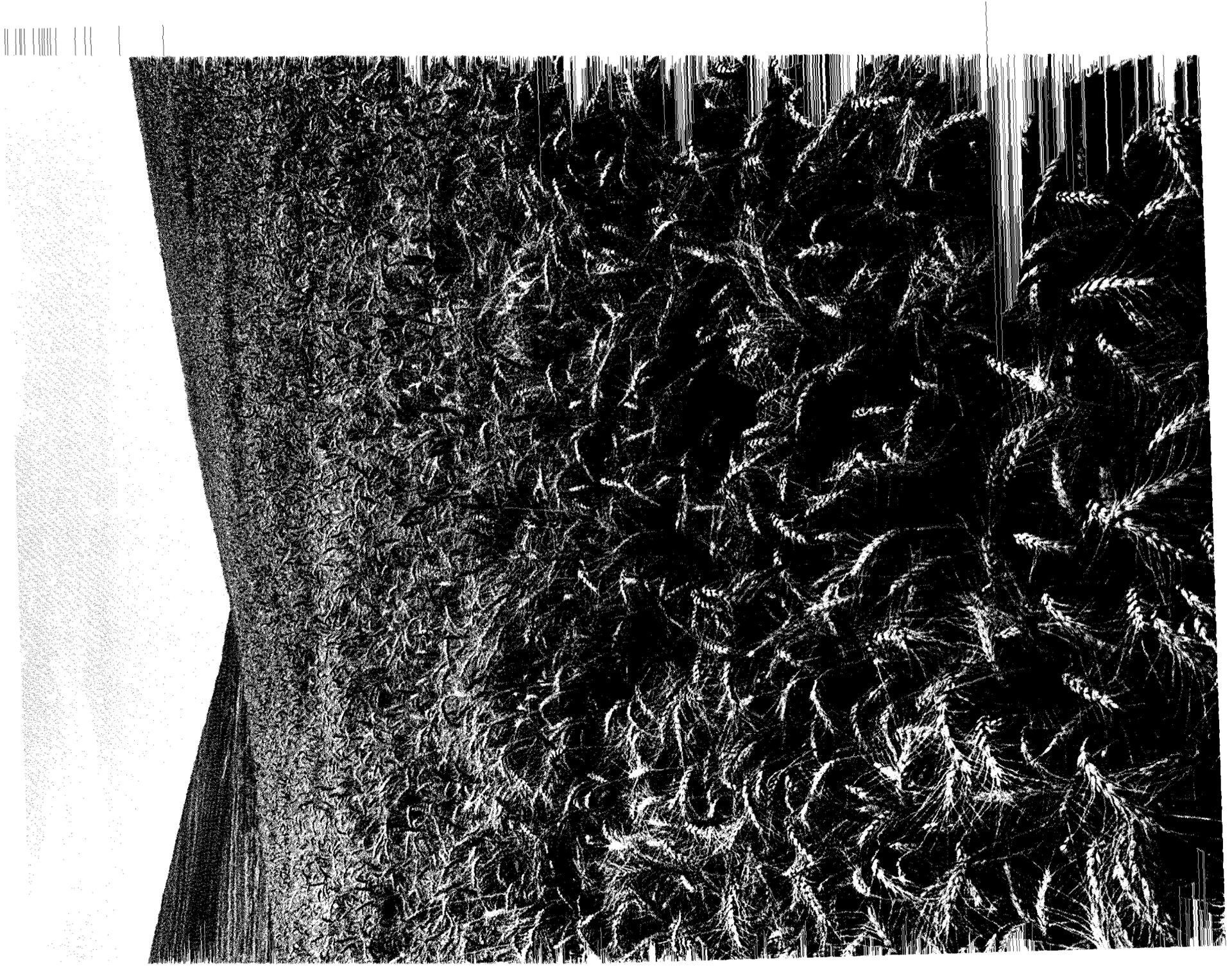
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# A No Regrets Strategy for Sustainable Development

Dramatic changes in political and economic systems, the increasing clout of non-governmental organizations and multinational corporations, unprecedented advances in global telecommunications, extraordinary growth in population and consumption, the invention of new international institutions, and new insights into the relationships between human society and Earth's natural capital – all these have combined to forge a complex and daunting new prospect for our coming century.

To some extent, these trends offer hope of broadly improving the quality of life and providing a measure of economic security to a larger share of the global citizenry. Much of this progress could be undermined, however, by widespread – and potentially catastrophic – deterioration of the global environment.

With 5.8 billion people on Earth and a global GDP approaching \$30 trillion, human activities already are occurring at such a vast scale as to threaten the global life support system. For individuals, this system is the air we breathe, the water we drink, the food we eat, and the homes that shelter us. Globally, it is the atmosphere, which protects us from ultraviolet radiation; forests, rivers, and oceans, which provide water, filter waste, regulate climate, and produce vast quantities of food; and minerals and living resources, which provide raw materials for the global economy and other vital services such as pest control, pollination, and soil building and maintenance.

This life support system is itself under stress. Atmospheric concentrations of carbon dioxide (CO<sub>2</sub>) from fossil-fuel combustion are increasing. Industrial fleets are searching for ever-diminishing populations of marine fisheries. The increasing incidence of red tides is a clear signal that the world's oceans are in trouble. Freshwater scarcity threatens to cause regional conflicts.

To continue on the current course of rising population and consumption will require massive amounts of new coal, oil, and gas, millions of cubic meters of water, greater extraction of resources, more pollution, more soil degradation, and more land conversion. These pressures could, over the next few decades, disastrously alter global climate, create critical shortages of freshwater in some regions, and extinguish incalculable numbers of plant and animal species.

The social and political impacts are already manifest and getting worse. Environmental deterioration and mounting population pressures undoubtedly played a role in the recent social breakdowns and internal conflicts that occurred in Somalia, Rwanda, and Haiti. In many cases, these conflicts are accompanied by large-scale movements of people within nations and across boundaries. In the next century, disruptions caused by extreme weather fluctuations, food production shortages, land degradation, water shortages, massive pollution events, continued depletion of the stratospheric ozone layer, and other such developments could be more politically significant than traditional threats to national security.

# Creation is in Critical Condition

*Ecumenical Patriarch Bartholomew I*

It is with great sadness that we witness the exhaustion of our planet's biological treasures, depletion of non-renewable natural resources, pollution and indiscriminate over-fishing of our seas, continued destruction of life-sustaining old-growth forests, illegal trade of internationally protected species of fauna and flora, and accelerating temperature rise caused by so-called "greenhouse gases."

The latest developments in genetic engineering constitute another proof that to a great extent humanity has lost contact with its God-given limits and with the natural environment. What is more, the fatalistically designated "Third World" is almost always required to pay the price for the "development" and wealth of the few.

However, we should not feel that all hope is lost. The initiation of a dialogue among the world's nations, so widely covered by the mass media, can reverse the situation. The introduction of the notion of sustainability in international environmental legislation is another encouraging development. We also welcome the efforts by international organizations such as the United Nations and the European Union to gain control over global warming and conserve the earth's endangered ecosystems. Yet, as was made evident by the lack of enforcement of the Framework Convention on Climate Change and the Convention on Biological Diversity, and the multitude of opinions and positions expressed at the Rio Summit for the Earth and the recent Kyoto Conference on Climate Change, there is still a long way to go in making governments aware of the falsehood of the dilemma of choosing between "development" and conservation.

It seems that the main purpose of the majority of entities dealing with conservation is to establish a set of rules outlining how humanity should make use of nature from now on. Yet, the logic of destruction is precisely the same as that of the protection of the environment. These two "logics" only differ quantitatively. The underlying ethic of the modern environmental movement treats nature in a utilitarian way, as a commodity. This attitude fits the high-

ly consumeristic prevailing mentality perfectly.

The truth is that humanity becomes aware of the environmental crisis and is willing to readjust its attitude toward creation only in so far as the natural environment is essential to the continued survival of the human race. Were our own existence not dependent on this fact, were the earth and the animals and plants simply beautiful, we might never have noticed anything wrong with our attitude. Of course, this is where the church and all religions in general make their greatest contribution to the whole issue of environmental protection.

It is true that saving our natural world is at the critical stage and time indeed is limited. In order, however, to achieve long-lasting solutions and avoid repeating the mistakes of the past, we cannot afford to treat creation with fragmented views. Science has solved many problems but has not been able to grasp the holistic nature of creation and its relation to the uncreated. Nor can science on its own achieve long-lasting solutions to this crisis, since all the world's problems affect the crisis in one way or another. The church sees the fundamental problem as one of ethos; and to bring about a change in ethos there is a growing need for a unified treatment of the cosmos by science and religion.

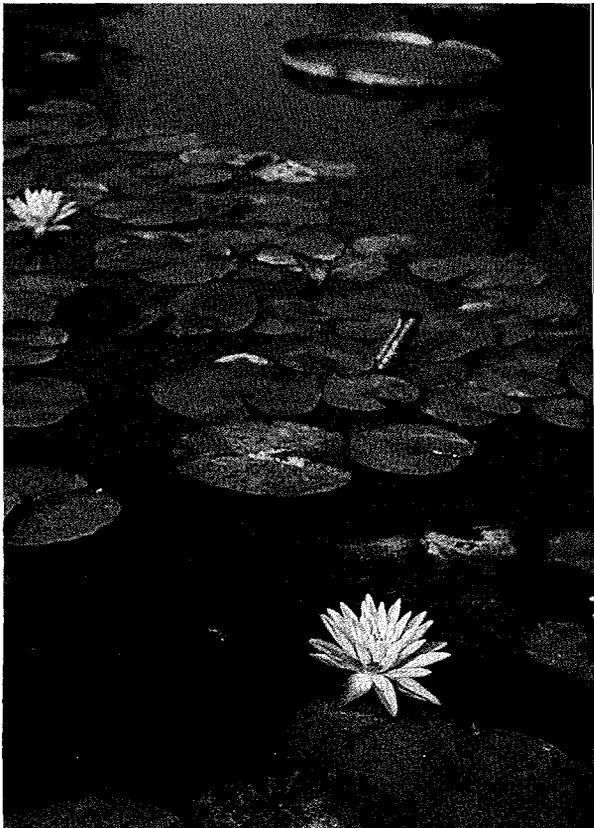
The cosmology of the Orthodox Church is essentially liturgical and eucharistic. The term eucharist originates from the Greek word *eucharisti*, which means thanksgiving. Yet, for the Christian East, this tradition of giving thanks to the Creator is not an individualistic matter. The divine eucharist, the preeminent Christian mystery and sacrament, is a communal act, a liturgy.

During the divine liturgy, the faithful convey profound understanding of creation and engage in a loving relationship with the whole world. It is the entire creation that worships God and offers up gifts. Water, light, wine, and bread all become means through which the world in its entirety is referred back to the Creator. Likewise, the architecture of church buildings and how they are decorated are the representation of the cosmos in its ideal state.

The Ecumenical Patriarchate calls all humanity to a loving and eucharistic relationship with creation. We also call on the governments of the world's economically powerful nations to sincerely and wholeheartedly assume their responsibility toward the current critical condition of God's creation.

By joining the concerted efforts of science and religion there can be a crucial understanding of "valuing the global environment." Placing real value on the global environment will reflect a dynamic attitude and commitment on the part of all humankind and at all levels — economic, social, intellectual, and spiritual. This will allow humankind to realize more fully the whole person placed within us by God while assuring that the natural environment we call home will be sustained by us and will sustain us for ages to come.

*In the summer of 1997, Patriarch Bartholomew hosted 300 scientists and religious leaders to discuss environmental problems on a week-long symposium aboard a ship travelling around the Black Sea.*



There is a growing list of issues that require global cooperation to solve: climate change, biodiversity loss, the pollution of international waters, widespread deforestation and land degradation, the emergence of persistent organic pollutants, transboundary movement of toxic materials, and management of global fishery resources, to name just a few.

In response, a broad array of global actors — local, regional, and national governments; international institutions; NGOs at all levels; scientists; business — have created new political and institutional arrangements, including international agreements on climate change, ozone depletion, biodiversity, marine fisheries, desertification, and others.

To succeed, the parties to these agreements must carefully reconcile the inherent tensions between short-term growth and long-term survival. Global economies are highly competitive, do not require common consensus prior to action, and have a short-term time horizon; global environmental issues require common consensus, provide benefits that will be shared by all, and have a long-term time horizon. Furthermore, nations are at vastly different stages of development, raising difficult questions about the equitable sharing of responsibilities in the management of global environmental issues.

As things now stand, it is uncertain whether half or more of the world community will share much of the material benefits of global economic growth. But there is little doubt that they will be the principal victims of a deteriorating global environment.

These outcomes are neither certain nor inevitable. With the advantage of several decades of experience, we know that they can be avoided with the right set of policies and global commitments, a renewed push to include the entire world community in this economic advance, and a much stronger guarantee to protect the global environment for current and future generations.

# Environmental Security is Indivisible

*President Maumoon Abdul Gayoom,  
Republic of Maldives*

Scientists believe that over the next 100 years, the average temperature of the earth will increase by 1.5 to 3 degrees Celsius. This contrasts with the fact that over the last 10,000 years, the earth's average temperature has not fluctuated by more than one degree. Thus, the predicted global warming will have serious repercussions worldwide.

The gravest danger is that sea levels will rise between 15 to 95 centimeters by the year 2100. This would inundate low-lying regions. In the case of the Maldives, which has an average height of only one meter above sea level, a major part of the country could be submerged. Flat coastal zones all over the world, many of them densely populated, would be flooded. Industries would be ruined. Economies would be crippled.

In addition to coastal erosion, heat stress would disrupt agriculture. Poor countries will be hard hit by rising cereal prices. Pests and diseases will spread, as ecological systems shift. Patterns of ocean currents could be disrupted. The ravages that El Niño has caused in the past would pale in comparison.

The longer we delay action, the fewer our options become. This will particularly disadvantage the small-island developing countries. It has been estimated that the cost of adaptation, on average, is two percent of GNP for small-island states and 0.5 percent for developed countries. In any case, for low-lying island states like the Maldives, relocation to higher ground is not an available option.

Devising appropriate responses requires careful examination of the causes. Global warming is the result of increasing atmospheric concentrations of carbon dioxide and other greenhouse gases. The primary cause of this is the overwhelming dependence of the world economy on fossil fuels. Rapid population growth has increased the world's energy

demands, especially in the worldwide quest for swift industrialization. Meanwhile, deforestation diminishes the Earth's natural ability to reduce atmospheric concentrations of carbon dioxide.

Carbon dioxide emissions released by the burning of fossil fuels account for about 50 percent of all greenhouse gases. Atmospheric concentrations of these gases have been rising steadily since the onset of industrialization, and more rapidly in the past 30 years. In the 1980s, such emissions averaged between 6-8 billion tonnes annually. The world's energy demand is expected to rise by 50 percent by the year 2020, and will keep on rising in the wake of increasing population, urbanization, and industrialization. Thus, if present trends continue, carbon dioxide emissions will rise to 12 billion tonnes by 2025, to 15 billion tonnes by 2050 and to 21 billion tonnes by 2100. A sustainable level of carbon dioxide emissions is no more than three billion tonnes annually.



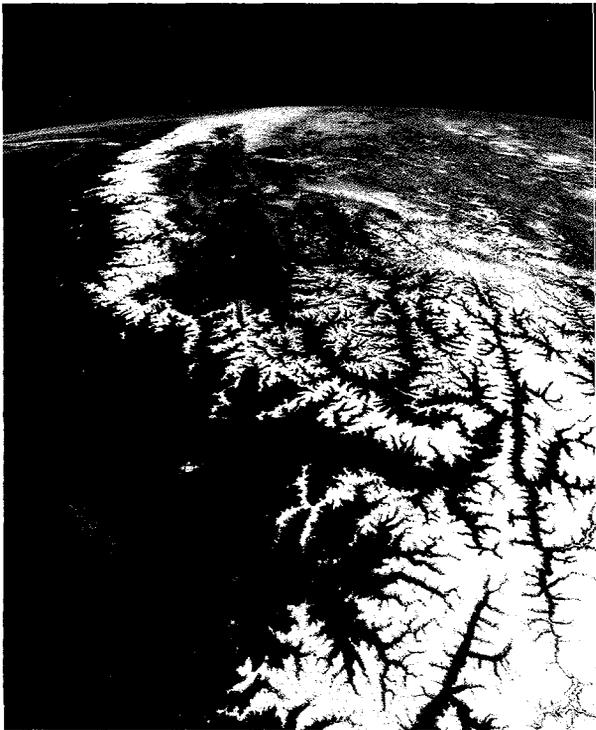
Urbanization and rapid population growth will add to these pressures. It is estimated that the rate of growth of private cars outstrips that of population. Producing more food, especially in areas of rapid population growth, will increase the emission of other greenhouse gases such as nitrous oxide and methane. At the same time, forests are disappearing at an alarming rate, about 16 million hectares per year. Burning of forests alone accounts for 20 percent of global carbon emissions.

The causes of global warming make the character of effective remedial action self-evident. Legally binding commitments to reduce greenhouse gas emissions are absolutely necessary. Tax measures could further encourage switching over to cleaner energy sources. According to the IPCC, energy efficiency gains of 10 to 30 percent are feasible at little or no cost. Using more sophisticated technologies, efficiency gains up to 60 percent are possible. New investment in research would be vital. Practical methods of transfer of benign technologies must be devised. Pricing the environment is fundamental for the sustainable use of ecological assets.

It will also be essential to introduce more effective forest management methods, including popular participation. Awareness-creation about what individuals can do would make an enormous contribution. Changes in lifestyles and consumption patterns would be of crucial importance. From family planning to reliance on public transport and waste recycling, families and individuals can also play a vital role.

Elements of regulatory, participatory, and market-based approaches must focus on all of the above aspects, and perhaps more. Most of all, it will be necessary to invest in common sense. What is required is a global partnership for a common fate. States, both rich and poor, must realize that environmental security is indivisible. In the battle for protection and preservation of the environment, there will not be a victor and a vanquished. We will all end up all winners or all losers.

*President Gayoom has been an outspoken proponent of a strong climate change treaty.*



Based on our current knowledge, enough is known to begin building a “no regrets” global environmental strategy for the next century. We should:

- Take low-cost actions immediately to protect the global environment, including strengthening existing and high-priority protected areas, continuing the phaseout of ozone-depleting substances, and investing in low-cost greenhouse gas emissions abatement.
- Invest in reducing risks of global catastrophe, including a major investment in research and development; improved knowledge of options, opportunities, and threats; improved dissemination of information through communications networks and public outreach; and strategic investments that reduce risks.
- Invest in long-term strategies to address the issues, including new technologies; in-depth understanding of the causes of global environmental threats; and sustainable market and trade systems that encourage and reward global environmentalism.

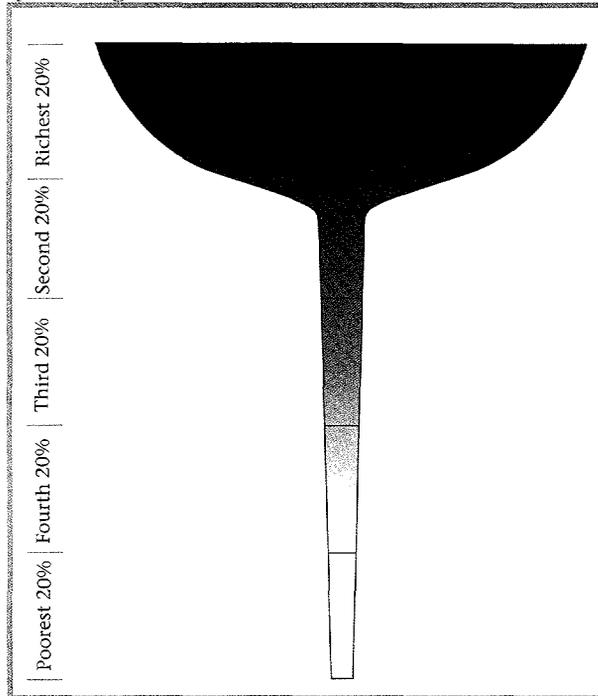
## Global Prospects

A number of global trends will have an important bearing on our prospects for protecting the global environment. They include: the unprecedented scale and increasingly global nature of the economy, both now and in the future; the rapid expansion of global telecommunications; the increasing participation of nongovernmental organizations and civil society in policymaking; the widening gap between rich and poor, and the possibility that many developing countries will gain little from future growth; the uneven nature of the demographic transition; and the rapidly increasing urbanization of the world.

*The scale of economic growth is unprecedented.* Global gross domestic product grew from about \$10.8 trillion in 1980 to about \$27.8 trillion in 1995, some 160 percent. Most of these gains occurred in 15 countries, bringing rapidly rising incomes to some of their 1.5 billion people.

Many developing countries – in East and Southeast Asia, and to some extent in South Asia and Latin America – are participating in this economic surge. Per capita income growth averaged 3.5 percent annually in all developing countries between 1960 and 1993. East Asia doubled that performance in the 1970-80 period. Recent economic reversals, however, pose new uncertainties about Asia's short-term economic future.

**1.1** Distribution of Economic Activity, 1991  
(percentage of world total)



Source: UNDP 1994

Other indicators of progress – overall living standards, education and literacy, mortality rates for infants and children, access to safe water and sanitation, reductions in population growth – also show impressive improvements in a significant number of developing nations.

Some regions and nations, including many in Sub-Saharan Africa, have not prospered to the same extent. Over the 1960-93 period, real GDP per capita increased five fold in East Asia, but hardly at all in Sub-Saharan Africa. Since 1980, some 100 coun-

tries – with a population of 1.6 billion people – have stagnated economically, with average incomes falling in two thirds of them. From 1990 to 1993, average incomes fell by one fifth or more in 21 countries, mostly in Eastern Europe and the Commonwealth of Independent States (CIS).

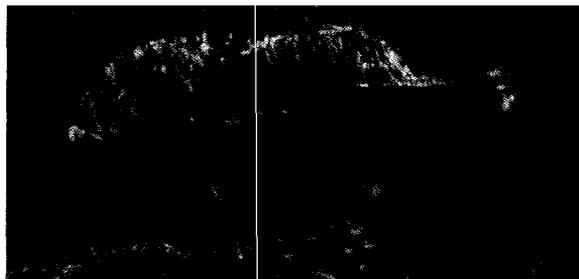
In both developed and developing nations, the bulk of the benefits are going to a relatively small share of the population. In the United States during the 1980s, for example, all the gains in male earnings went to the top 20 percent of the workforce – and 64 percent of those gains went to the top 1 percent. Over the past 30 years, the richest 20 percent of the world's people increased their share of global income from 70 to 85 percent, while the share of the poorest fifth dropped from 2.3 to 1.4 percent (Fig. 1.1).

Overall, trends in income distribution are mixed, with some nations – including India, Malaysia, Colombia, Costa Rica, Uruguay, and Canada – showing improvements in income distribution, while others – such as the Czech Republic, Russia, the United Kingdom, Brazil, and Thailand – show a pattern of widening income inequality. In a few East Asian nations – Japan, China, Malaysia – there appears to be a positive correlation between economic growth and income equality.

**The world is shrinking.** Virtually instant communication anywhere in the world is now possible and increasingly common. International telephone traffic tripled in the 1983-93 period. By mid-1996, the Internet was accessible in 174 countries and on all seven continents, linking together nearly 13 million host computer systems. By the year 2000, that number could well be 100 million. The World Wide Web – the multimedia part of the Internet – has grown from 130 sites in July 1993 to an estimated 80 million or more today.

Telecommunication networks are a dynamic new form of infrastructure for the modern economic system, comparable to railways in the nineteenth century and roads and airplanes in the twentieth

century. Unlike earlier transportation networks, these new forms of information sharing are relatively cheap and quickly expandable. The free market in ideas is expanding rapidly.



proportions, with more than a trillion dollars moving through it every day.

Some developing nations with low wages and high-technology skills are taking advantage of new global opportunities. For example, in just 10 years India has emerged as the world's second largest exporter of software.

**More actors are entering the world's stage.**

Non-governmental organizations are growing almost as explosively as telecommunications networks. An African NGO environment network grew from 21 members in 1982 to 530 members by 1990; similarly, an Indonesian environmental forum grew from 79 to over 500 members over the 1980-92 period. At the Rio Earth Summit in 1992, more than 1,400 NGOs were accredited to the official conference and 9,000 more NGOs participated in the parallel Global Forum.

High and rising per capita consumption – characteristic of developed countries for many years – is also emerging on a more limited basis in some developing countries.

NGOs are using the new telecommunications infrastructure to share information and build networks that cross hemispheric borders. They are the fabric of a new “global community” that is fundamentally altering the balance between states, markets, and civil society. Many governments, once the world's principal problem solvers, now increasingly are cast in a new role as facilitators, working with NGOs, intergovernmental organizations, international institutions, private corporations, and others to solve problems.

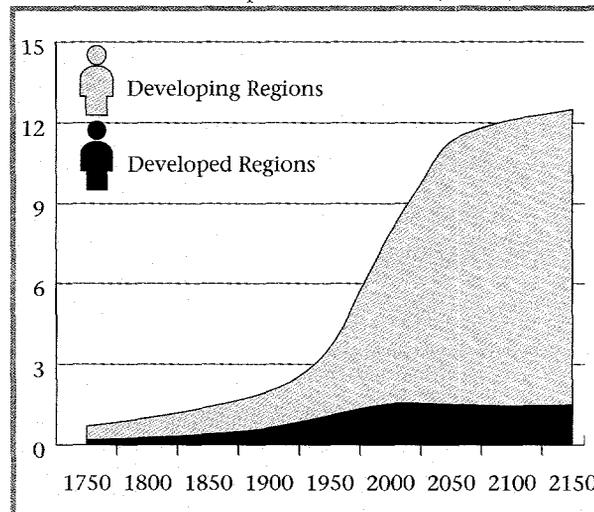
**Much of the world is being left behind.** While some of the world's citizens in both the developed and developing worlds are enjoying longer lives, better health, and rising incomes, others are being left behind. In Sub-Saharan Africa, parts of South Asia, and elsewhere, fertility rates remain high, economic growth relatively slow, and poverty a massive problem. Some 100 developing and transition countries are experiencing uneven economic growth.

On many other fronts, the pace of globalization is picking up fast. Corporations are increasingly multinational and eager to enter promising new markets in developing countries. International travel is now common, spurring new entrepreneurial partnerships and bridging cultural gaps that have endured for centuries.

More than one fifth of the world's people live on

**Economic activity is increasingly global in nature and market-based.** World merchandise trade tripled during the 1965-90 period, while trade in services increased more than 14 times. A global financial market has grown to enormous

**1.2 Trends in World Population, 1750-2150 (billions)**



Source: WRI 1996  
 Note: Projections based on the U.N. medium variant

# Challenging the Conventional Wisdom

Tommy Koh

The conventional wisdom at last June's special session of the UN General Assembly was that, environmentally, the world was worse off in 1997 than in 1992. I wish to challenge that assumption.

First, we have reached a historic reconciliation in the age-old debate between economic development and protection of the environment. To be sure, governments still have to make hard choices and there continue to be trade-offs between the two objectives. *But, since the Earth Summit, it is no longer possible to talk about development without considering its impact on the environment or to talk about protecting the environment without considering its economic costs.*

Second, the Earth Summit has empowered the environmental movement. Many companies have adopted mission statements which include environmental goals and have reformed their businesses to reduce waste in the production, consumption, and disposal of their products. The ISO 14000 is being embraced by more and more companies. Business leaders are aware that support for the environment is not inconsistent with profitability. Governments are more willing to listen to and work with non-governmental organizations. The environmental ethic is increasingly popular with students and other young people.

Third, the Framework Convention on Climate Change has come into force. The Kyoto Conference of Parties in December 1997 should be viewed, not as a failure, but as another step towards the protection of the earth's atmosphere. I welcome the agreement to reduce the emissions of greenhouse gases by 5.2 percent by 2010. I also welcome the agreements to permit emissions trading among the developed countries and between developed and developing countries. I am disappointed, however, that the Kyoto Conference was unable to overcome the cleavage between the developed and developing countries and to forge a new sense of solidarity to protect one of the world's most important global commons.

Fourth, the Convention on Biological Diversity has also come into force. Progress has been made by State Parties to inventory their biological diversity and to publish Red Data Books containing their endangered species of flora and fauna. The World Conservation Union-IUCN and World Wide Fund for Nature (WWF) have awakened the world's conscience and are helping developing countries to conserve their biological diversity and use their natural resources in a sustainable manner. Although we continue to lose at least three species of flora and fauna every day, the prospect is better today than five years ago that we will slow down, if not arrest, this trend.

Fifth, a new convention to combat desertification has been negotiated and come into force. Let us support this convention with the necessary political will and economic resources so that it will make a difference to those countries, especially in Africa, which are faced with the threat of desertification.

Sixth, the 1982 Convention on the Law of the Seas has also come into force; a new agreement on straddling fish stocks and highly migratory fish stocks has been adopted; a conference to protect the marine environment from land-based activities has been held; and we have a new code of conduct on responsible fisheries. We should work for a convention to protect the marine environment from land-based pollution, which accounts for 75 percent of marine pollution. We should bring all the relevant international agencies to work together and manage the oceans in a holistic way.

Seventh, the 1996 UN Conference on Human Settlements has underlined the fact that by the year 2000, half the world's people will live in cities. In East Asia, the challenge of making our cities sustainable remains formidable; most of our citizens do not have access to drinking water, modern sanitation, and adequate housing.

Eighth, the World Trade Organization is making slow but steady progress in elucidating the relationship between trade and environment. I am confident that in 1998, its Ministerial Conference will be ready to adopt substantive decisions on this important question.

Ninth, progress has been made in capacity building. Many countries and international organizations have implemented programs to share their experience and to train personnel from developing countries. This is more important than money because, without a core of competent individuals, nothing will succeed.

Tenth, the goals of the Earth Summit can only be realized if we win the hearts and minds of the citizens of the world. We have to inculcate in every child a love of nature. We have to influence the daily habits and lifestyles of people all over the world. In these respects, we are making progress. Compared to five years ago, we live in a greener and safer world.

*Professor Tommy Koh is Singapore's Ambassador-At-Large.*



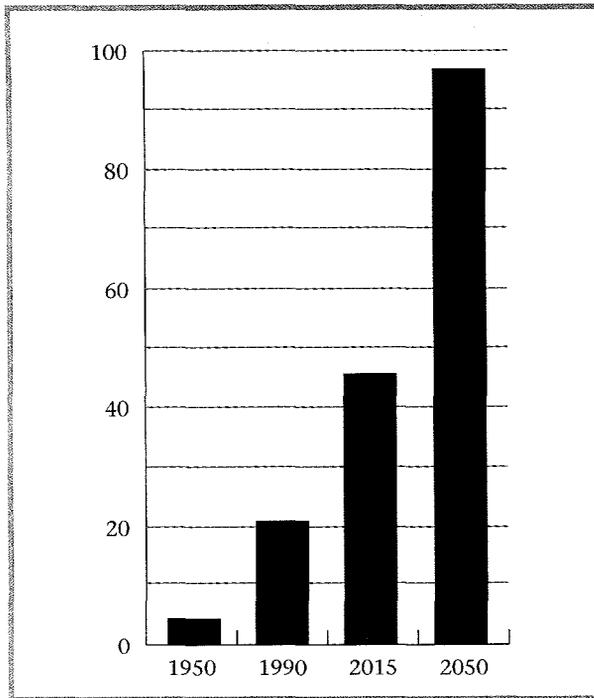
less than \$1 per day. South Asia has the largest number, about 515 million, followed by Sub-Saharan Africa with 215 million, and Latin America with 150 million. Women are disproportionately poor, burdened by the multiple strains of work and child care, and hampered by lack of access to credit, land, and better employment opportunities. In addition, nearly a billion people are illiterate, and well over a billion lack access to safe water.

***The gap between rich and poor nations is widening, though not along traditional North-South lines.*** The 49 countries listed in the "low-income" category by the World Bank are concentrated in Sub-Saharan Africa and South Asia. Among these nations (excluding China and India), GNP per capita is estimated at \$290 in 1995, life expectancy at birth is 56 years, and adult illiteracy is estimated at 46 percent. In the "upper-middle-income" category – including South Africa, Mexico, Mauritius, Gabon, Brazil, Malaysia, Chile, and others – adult illiteracy is 14 percent, life expectancy is 69, and GNP per capita is \$4,260. Among the "high-income" countries, illiteracy is negligible, life expectancy is 77, and GNP per capita is \$24,930, or some 86 times greater than the average in low-income countries.

Gaps within nations can be just as great as gaps between nations. A recent study of 2,000 cities and counties in the United States found that African-American males living in Washington, D.C., had a life expectancy in 1990 of just 57.9 years, which is only slightly higher than the average life expectancy in the poorest developing nations and fully two decades less than combined life expectancy for the United States as a whole.

Nearly 840 million people are undernourished, and the number of chronically undernourished in Sub-Saharan Africa has more than doubled since 1969. Recent estimates indicate that a number of countries in Sub-Saharan Africa and South Asia and a limited number in Latin America and the Caribbean have experienced serious declines in per

1.3 Global GDP Growth, 1950-2050 (trillion 1990 US\$)



Source: UNEP 1997

capita food availability since the mid-1980s.

**The demographic transition is taking hold unevenly.** Global population continues to surge, rising from the current 5.8 billion to perhaps 8-10 billion by the middle of the next century (Fig. 1.2, p. 9). Fertility rates are falling rapidly in East and Southeast Asia, which are enjoying generally rapid economic growth, but remain persistently high in Sub-Saharan Africa and parts of South Asia.

**The world is rapidly urbanizing.** Even in the wealthiest developing countries, urban governments are struggling to provide new infrastructure to keep pace with population and economic growth. Air pollution already exceeds health standards in many megacities in developing countries. Sewage and industrial effluents are generally untreated. Roughly two fifths of the world's larger cities over 500,000 are situated in coastal areas and are expanding into fragile coastal ecosystems. World motor vehicle ownership is forecast to increase dramatically in cities around the world, yet the end result may be greater congestion and local air pollution rather than increased mobility.

## A "Business as Usual" Future?

Using conventional assumptions about growth in the next few decades, where might the world and the global environment be heading? Can the world make the transition to sustainable development without any further changes in policies or life styles?

Large increases in global population and economic activity seem assured. Global population could grow to perhaps 8 billion by 2025 and 10 billion by 2050. Global gross domestic product, which stood at about \$21 trillion in 1990, could double to \$45 trillion by 2015 and double again to \$95 trillion by 2050 (Fig. 1.3). Though not rising as rapidly as GDP, primary energy consumption in 2015 could be nearly double that of 1990 levels (Fig. 1.4).

Most "business-as-usual" models factor in incremental improvements in efficiency and technical advances, but also assume that there will be no significant changes in environmental policies or in the degree of regulatory pressure applied. Projected into the future, these models consistently find that the rapid increase in the scale of economic activity easily overwhelms the assumed improvements in production technologies and pollution control.

Such scenarios suggest much greater levels of air and water pollution, burgeoning amounts of solid waste, much greater pressures on remaining biodiversity and natural ecosystems, and a substantial increase in the risk of climate change resulting from much higher emissions of greenhouse gases. Though water and food availability may be adequate at the global level, regional deficiencies could certainly emerge or worsen.

**Energy and Climate.** Global energy production and consumption have risen steadily for several decades; in the 1975-95 period, global production was up about 50 percent. Energy consumption has declined since 1989 in the former Soviet Union and Central Europe. Many factors have contributed to this trend, including the general slow-

**1.5 Projections of Energy Consumption, 1990-2020**  
World Energy Council Scenarios

| Projection period   | High Growth | Modified Reference | Reference | Ecologically Driven |
|---|-------------|--------------------|-----------|---------------------|
|   | 1990-2020   | 1990-2020          | 1990-2020 | 1990-2020           |
| <b>Economic growth, percent per year</b>                                    |             |                    |           |                     |
| OECD countries/ Former Soviet Union and Central Europe                      | 2.4         | 2.4                | 2.4       | 2.4                 |
| Developing countries  | 5.6         | 4.6                | 4.6       | 4.6                 |
| <b>Percent increase in world energy demand over projection period</b>       | 98          | 84                 | 54        | 30                  |
| <b>Percent increase in annual carbon dioxide emissions over 1990 levels</b> | 93          | 73                 | 42        | 5                   |

Source: World Resources Institute 1996

down in economic activity during the difficult transition to a market system, the shutdown of inefficient enterprises, and some improvements in energy efficiency.

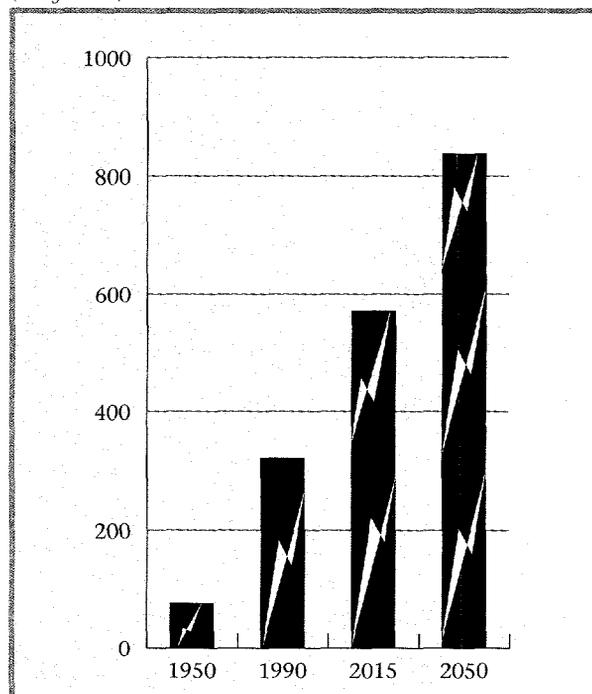
Although per capita energy use varies widely from nation to nation, average energy use per person is still more than nine times greater in developed than in developing nations. Population growth in developing nations has kept per capita energy use very low compared with that in the developed world, with most of the increase in energy use devoted to meeting the basic needs of industry and the public. In many developing nations, brownouts and blackouts are common. Coping with rising energy demand is a major challenge.

Several institutions – the World Energy Council, the International Energy Agency, the U.S. Department of Energy, and others – have developed scenarios for future energy consumption.

WEC's reference case assumes relatively rapid improvement in energy efficiency; rapid technology transfer; good progress in energy planning and pricing; a slow expansion of renewable sources; and a substantial increase in supplies of fossil fuels. It assumes a "moderate" economic growth rate of 2.4 percent per year in OECD and transition countries and of 4.6 percent per year for developing

countries as a whole. Under these assumptions, WEC projects a 54 percent increase in energy demand by the year 2020 and a 42 percent increase in annual carbon dioxide emissions (over 1990 levels) (Fig. 1.5).

**1.4 World Primary Energy Consumption, 1950-2050**  
(Exajoules)



Source: UNEP 1997

Note: One exajoule = one quintillion ( $10^{18}$ ) joules

# A New Environmental Ethic

Gertrude I. Mongella

Human economic activities of the last century have increasingly generated pollution, toxic wastes, large scale deforestation, desertification, drought, and depletion of the Earth's soil, coastal, and marine resources.

While poverty creates certain kinds of environmental stress, the major — and most difficult to reverse — cause of global environmental deterioration is found in unsustainable patterns of consumption and production, particularly in the industrialized countries. The environmental impact of human activity is no longer restricted to national borders. What people do within one nation can today have an impact on the globe as a whole, and affect our shared natural heritage, such as the oceans, the ozone layer, the world's biosphere, and biodiversity.

In the last decade nations have put in place ecological treaties like the Montreal Protocol, the Framework Convention on Climate Change, the Convention on Biodiversity, and the Convention to Combat Desertification. Much attention seems to be focused on climate change and the ozone layer, yet not enough is being done for the environmental problems facing poor societies — which have to do with deterioration of soils, pollution, paucity of water, and poor sanitary conditions.

The problems of environmental degradation go beyond scientific and technological solutions. They require a re-establishment of environmental ethics and values practiced in traditional societies and which still exist among the so-called indigenous and traditional people of Africa, Asia, and Latin America. We have to re-examine their respect for nature and their philosophy on the co-existence of human beings, animals, plants, the soil, the water, the air, the sun, and the moon.

In the society where I grew up, knowing the environment was part of a life-long education. In order to survive, one had to learn the names, uses, and dangers of plants, insects, birds, animals, and soils. Rivers, lakes, mountains, forests, rocks, and big trees

were respected and sometimes worshipped.

In my tribe, which exists on an island in Lake Victoria, we had several gods — the God of the Sun, the God of the Water, and the God of the Land. We had holy places set apart from human activities. I have come to learn with great surprise that these were water catchments or areas where special medicinal plants grew. With the coming of Christianity and modern civilization the taboos have been violated, forests have vanished, and rivers dried up. The women now have to go a long distance looking for water and firewood.

There is no child today who can name the number of birds, insects, plants, herbs, and fishes that I knew at her age. That is why such children find the taboos that protected the environment meaningless. One cannot love what one does not know. Many people today do not know the natural environment they live in. They, therefore, have no love for it. Market forces are forcing them to uproot and sell all that has a price. The consumer lifestyle is greedy and has no limit. It takes in everything and destroys every natural resource to meet the growing demands of the market.

The language of international discussions and debates on environment are too far removed from ordinary people. The people who interact daily with the environment are alienated by science and technology. They have become the victims of modernization and development. The causes of and solutions to environmental degradation are commonly known to us. The minds which developed the science and technology that caused pollution, global warming, toxic wastes, landmines, etc., can be used to reverse the negative impact on development.

What is needed are new environmental ethics. Civil society has demonstrated a strong capacity for advocacy, lobbying, and networking for the protection of the environment. Through NGOs, an environmental ethic can emerge more quickly, supported by women, youth, and community leaders. The government's responsibility to regulate and monitor the use of science, technology, and economic activities remains crucial to environmental protection.

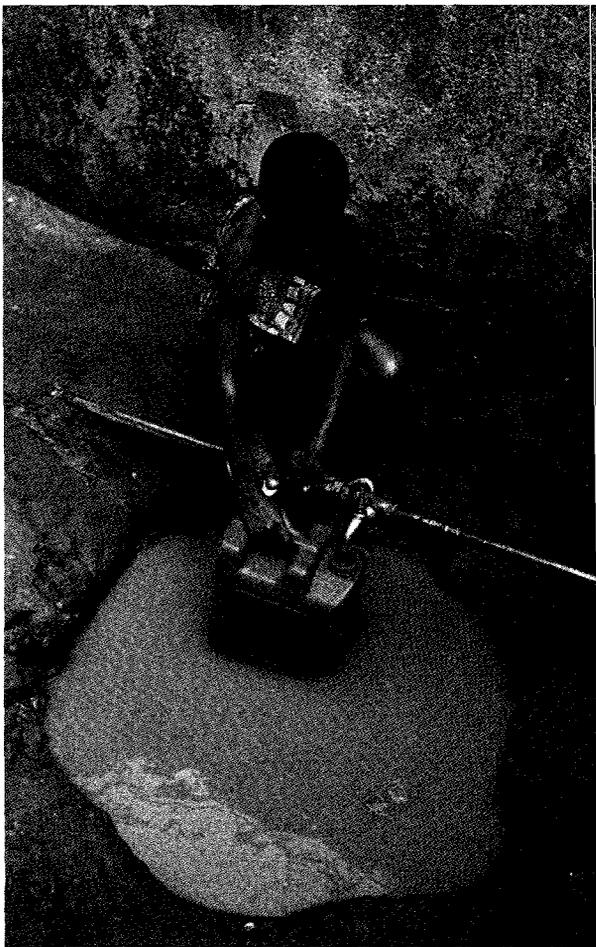
In order to address the problems of environmental

degradation and particularly the problems of climate change, ozone depletion, and destruction of biodiversity, nations must be committed to creating an alternative economic system to replace the profit-oriented global economy based only on free trade, permanent growth, comparative advantages, competition, and profit maximization.

Finally, our education systems must produce people who:

- Have the integrity and respect of nature and her species.
- Have an understanding of human beings as part of nature and not only as masters of nature.
- Recognize the need for protection of biodiversity in production and consumption.

*Ambassador Gertrude Mongella of Tanzania was Secretary-General of the Fourth World Conference on Women in Beijing, China.*



With slightly higher growth in developing countries, the outlook for energy consumption is significantly greater. Under the WEC "high-growth" model, growth in OECD and transition economies stays the same, but the assumption for developing countries is pushed up slightly to 5.6 percent. That scenario results in a near doubling in energy demand and carbon dioxide emissions by 2020.

There are some grounds for optimism about energy and climate, notably the December 1997 meeting of the Parties to the Framework Convention on Climate Change. The decisions reached at Kyoto, discussed in Chapter 5, represent a reversal of current trends and a first step towards altering business-as-usual in energy use.

**Water.** The global supply of freshwater is finite, yet demand has risen by an average of 2.5 percent per year since 1940, which is actually faster than the rate of population growth. Global water withdrawals are now approaching 4,000 cubic kilometers per year, and show few signs of slackening off.

A 1997 assessment by the United Nations includes a projection of freshwater withdrawals through the year 2025. Under this projection, withdrawals would continue to increase to over 5,000 cubic kilometers per year, with over three fifths of the total used for agriculture and about one fifth for industry.

Another UN estimate by the Department of Policy Coordination and Sustainable Development expects greater shifts towards less water-intensive activities and higher levels of water efficiency. Under this scenario, total withdrawals would rise to 4,300 cubic kilometers by 2050. Other estimates show a 50 to 100 percent increase in water demand over the next 30 years.

Even under the most optimistic scenarios, total withdrawals would continue to rise significantly above current levels, reducing per capita water availability and potentially throwing more people and nations into conditions of water stress and conflict.

**1.6 Non-Domesticated Land as a Percentage of Total Regional Land Area, 1990-2050**

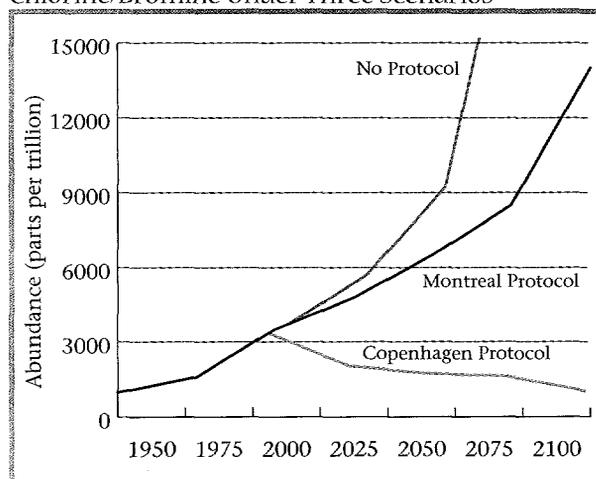
| Region                      | 1990      | 2015      | 2050      |
|-----------------------------|-----------|-----------|-----------|
| Africa                      | 70        | 55        | 45        |
| Asia and Pacific            | 60        | 50        | 55        |
| Europe and former USSR      | 75        | 75        | 70        |
| Latin America and Caribbean | 70        | 65        | 60        |
| North America               | 80        | 80        | 80        |
| West Asia                   | 90        | 75        | 70        |
| <b>World</b>                | <b>70</b> | <b>65</b> | <b>60</b> |

Source: RIVM/UNEP 1997

By the year 2025, almost two thirds of the world's people will be living in areas with moderate to high water-management difficulties, and roughly half the world will find it difficult to cope with these problems because of financial constraints.

By 1994, about 1.2 billion people in developing countries (25 percent of the total) lacked access to safe water supplies and nearly 3 billion people (66 percent of the total) lacked access to sanitation services. By the year 2000, according to UN projections, those without access to safe water should

**1.7 Projections of Ozone-Damaging Stratospheric Chlorine/Bromine Under Three Scenarios**



Source: WMO 1995

decline to about 15 percent of the total, but those without sanitation services are projected to increase to 68 percent of the total.

**Fisheries.** Overharvesting by large-scale industrial fleets, smaller commercial vessels, and subsistence fishers have depleted this vital resource. After nearly a fivefold increase in the marine fish catch between 1950 and 1989, the marine harvest (excluding aquaculture) leveled off in a range of 84-88 million tons annually during the 1987-93 period, and then jumped to 93 million tons in both 1994 and 1995. The Food and Agriculture Organization of the United Nations (FAO) estimated in 1993 that more than two thirds of the world's marine fish stocks were being fished at or beyond their maximum level of productivity. In the northern Atlantic, the catch of Atlantic cod has plunged to about one fourth the size in the late 1960s, while off the Asian coast in the Pacific it is estimated that every assessed fish stock is being exploited at or beyond sustainable limits.

By 2020, experts expect that the marine fish catch will be about the same or below the current level. Gains from better handling of catch, more use of "bycatch" (undersized or low-value fish that are often discarded), and greater exploitation of the few remaining underused stocks will likely be more than offset by losses from poor management, lack of protection of areas and species from fishing, and worsening marine and coastal environmental quality. World aquaculture production will increase, but not at the rate needed to maintain the present per capita supply.

**Biodiversity.** Habitat loss and fragmentation, environmental degradation, and other factors clearly are putting severe pressure on many species of plants and animals, though precise descriptions of current conditions and future trends are severely hampered by lack of information.

The most comprehensive source of information on extinctions and threats of extinction are the Red Lists and Red Data Books compiled by the World

Conservation Monitoring Centre. In 1994, it was estimated that 11 percent of birds, 18 percent of mammals, 5 percent of fish, and 8 percent of plants were globally threatened. These numbers refer only to those relatively small number of species about which enough is known – in terms of population size, trends, and potential threats – to make judgments about their status, not to the vast majority of the world's 1.75 million described species and the millions of undescribed species.

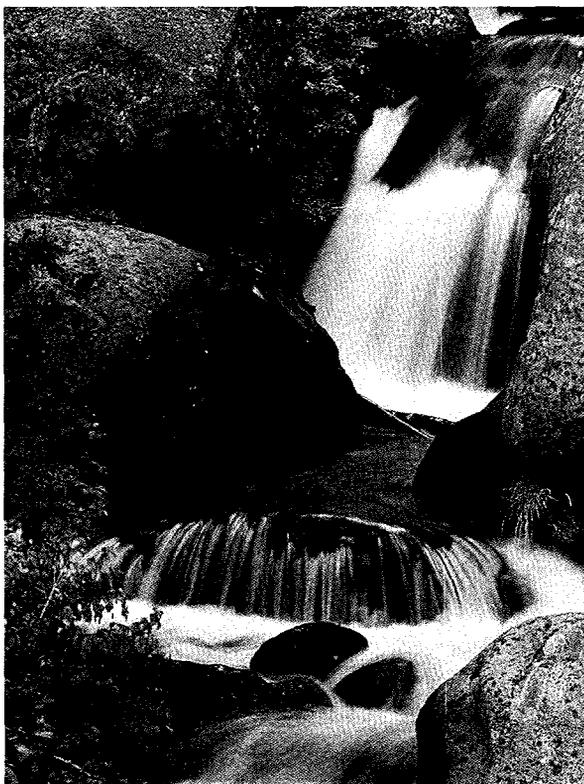
Islands and freshwater ecosystems are particularly vulnerable to species loss. For example, some 23 percent of island bird species are threatened, compared to 11 percent of birds globally.

Mediterranean-climate regions are also particularly vulnerable, due in part to recent habitat change, introduced species, and a high degree of local endemism of plants. It is estimated that 15 percent of vascular plants are threatened in the Mediterranean zone of California, 17 percent in the Cape Province of South Africa, and 24 percent in southwest Australia.

Research to date has found that the number of species in a given habitat depends on the area of the habitat. The species-area relationship is a useful way to project impending rates of extinction due to habitat loss, though there are many uncertainties that cloud these projections. In tropical forests, for example, it is estimated that from 2 to 25 percent of species will become extinct or will be committed to extinction over the next quarter century.

Based on estimates of likely rates of loss in tropical forests, which contain about half of the world's species, it is estimated that up to 10 percent of the world's species will become extinct or will be committed to extinction over the next quarter century. These rates are about 10,000 times the average expected "background" rates.

Overall, the world's natural habitat is projected to come under increasing pressure. Non-domesticated land area is projected to drop from the current 70



percent to about 65 percent in 2015 and then 60 percent in 2050, mainly as a result of cropland expansion (Fig. 1.6).

The highest rates of land conversion are expected in Africa, where the proportion of non-domesticated land could fall from 70 to 45 percent by 2050. In West Asia, it could drop from 90 to 70 percent. Grassland/savannah would be largely converted to permanent pasture; forests would to a great extent disappear; and the remaining non-domesticated area would be largely arid and semi-arid land.

## Reinventing the 21st Century

Projections of the future are not inevitable, and in fact there are several examples where business-as-usual outcomes have been avoided. The most notable global example is stratospheric ozone.

In June 1974, two chemists – F. Sherwood Rowland and Mario J. Molina – at the University of California/Irvine published a paper theorizing that chlorofluorocarbons released into the environment

# The Montreal Protocol: A European Perspective

Ritt Bjerregaard

The Montreal Protocol is without question an outstanding example of effective international cooperation towards the solution of a global environmental problem. Agreed in 1987, its objective was to phase out the manufacture and use of chemicals depleting the Earth's protective ozone layer. Ten years later, over 160 countries are now Parties, representing over 95 percent of the Earth's population.

Production and consumption of CFCs, carbon tetrachloride, halons, and methyl chloroform have been phased out in developed countries, with reduction schedules and future phaseout dates agreed for HCFCs and methyl bromide. In 1999, developing countries will freeze their production and consumption of CFCs, with phaseout scheduled for 2010.

The concentration of some CFCs in the atmosphere has started to decline, and the best scientific predictions are that Earth's ozone layer could recover by the middle of the next century. Among the many reasons for these achievements, three merit particular attention:

- **Global agreement on the nature and seriousness of the threat.** Even the strongest skeptics could not deny the Antarctic ozone hole which was first brought to international attention by British scientists in 1985. We understood for the first time that emissions of ozone-depleting substances were in reality putting our lives and the lives of future generations at risk. Decisive action was required.

- **A cooperative approach, especially between developed and developing countries.** In Europe we recognized that our industries had contributed significantly to this global problem and that we had to take a lead in stopping emissions and finding alternatives. We also knew that solving the ozone problem required a global solution, with all countries committed to eliminating ozone-depleting substances. Therefore we agreed to an innovative partnership,

including early controls for developed countries and a grace-period, funding, and technology transfer for developing countries.

- **Policy based on expert and impartial advice.** The Parties to the Montreal Protocol are fortunate to receive impartial advice from their science, technical, and economic committees. These draw together experts from around the world, including many European governments and industries, to evaluate the need for further action and propose options that are technically and economically feasible.

Put these three factors together – acknowledgment of the threat, agreement to cooperate, and commitment to take effective action based on expert advice – and we have a potentially strong recipe to solve not only the ozone layer problem but also other global issues, such as climate change and biodiversity loss, which threaten our future survival.

Within the common framework of the Protocol, the European Community has sought to go further and faster, including CFC phaseout one year ahead of schedule. This reflects a strong environmental conscience but also the conviction that tight targets can drive the market towards more environmentally-friendly alternatives. For example, Europe now leads the world in hydrocarbon refrigeration technology, developed through an innovative partnership between environmental interest groups, governments, and industry.

But there is much still to do. In Europe we are currently living through the worst ever ozone depletion – 40 to 50 percent over Northern Europe in each of the last three winters. This ozone depletion will inevitably take its toll on human and animal health, plants, and ecosystems. Even the most optimistic forecasts show that this level of depletion will continue into the next millennium and that full recovery will be slow. Further measures are necessary but the difficulties are numerous.

First of all, the problem of non-compliance. Illegal CFCs are smuggled into Europe and elsewhere, while production of CFCs continues in some countries even after the phaseout date. Strong, internationally coordinated action is urgently required to

address these difficulties so that they do not undermine the Protocol. We need to remind ourselves that the environment is not protected simply by text on a page but by all Parties fully implementing their commitments.

A second challenge is to complete the phaseout of all ozone-depleting substances. It cannot be right that HCFCs should remain the only ozone-depleting substances whose phaseout is unlikely to happen in our lifetimes (currently 2030 for developed countries, 2040 for developing countries) and whose production is still completely uncontrolled. Europe has taken a lead in trying to advance these dates, but our partners have so far failed to follow. It is also difficult to see how increased global use of methyl bromide is compatible with our declared aim to protect the ozone layer nor why it should be necessary, given the good alternatives now becoming available.

Several European countries have set themselves the target of phasing out the use of all ozone-depleting substances early next century. This is an ambitious but achievable target, and one that I hope others will follow as part of their sincere commitment to ozone layer protection and sustainable development.

*Ritt Bjerregaard is Environment Commissioner for the European Union.*



would rise into the stratosphere and release chlorine atoms that would react with and destroy the Earth's thin layer of stratospheric ozone. A second paper in 1975 predicted that this process could significantly deplete the stratospheric ozone layer. Under such conditions, increasing amounts of ultraviolet radiation could reach the Earth's surface, potentially harming plants and animals and increasing human health problems such as skin cancer and cataracts.

Those theories became shocking reality in 1985 with the discovery of a massive "hole" in the ozone layer over Antarctica. This hole has continued to occur during the southern hemisphere's spring, and the severity of the problem worsened in the early 1990s. In October 1992 and October 1993, research indicated that the ozone layer over the Antarctic was more than 99 percent depleted.

The global political community agreed in 1987 to control CFCs and halons, which were also implicated in the ozone-depletion problem. The original 1987 Montreal Protocol on Substances that Deplete the Ozone Layer required industrialized countries to reduce CFC consumption by 50 percent by 1998 and freeze halon consumption in 1992. As the ozone-hole problem worsened in the late 1980s and early 1990s, the parties agreed (at London in 1990 and Copenhagen in 1992) to completely phase out halons by January 1994 and CFCs by January 1996.

In response to this agreement, governments in industrialized nations devised an array of strategies, including marketable permits, excise taxes, and other market-based instruments, as well as the removal of regulatory barriers and other government initiatives. The results to date have been remarkably successful, and in many cases they have proven to be an opportunity rather than a burden to entrepreneurs.

As Figure 1.7 on page 16 shows, ozone-damaging chlorine and bromine would have increased rapidly through the first half of the next century without the Montreal Protocol. With the Copenhagen

amendments in place, it is estimated that atmospheric concentrations of these substances are about to peak and should begin a slow decline.

Despite the agreement, the recovery of the stratospheric ozone layer will be a long process. Decreases in ozone of about 4-5 percent per decade in mid-latitudes in the northern and southern hemispheres are continuing to be measured, and a substantial ozone hole is still expected for many more decades.

This case provides some grounds for optimism that – if the public and private sectors create the right combination of policies, incentives, and pressures – alternative scenarios are achievable. It provides many valuable lessons, including:

- The importance of precaution and foresight in assessing the potential long-term impacts of new technologies.
- The value of establishing impending threats to human health and the global environment as scientific fact.
- The value of multi-stakeholder interaction. In the ozone case, the involvement and contributions of all affected stakeholders – despite substantial differences in interests and perspectives – was crucial to success.
- The effectiveness of market mechanisms as policy instruments, and the high leveraging potential of regulatory change.

As difficult as the effort to phase out ozone-depleting chemicals has been, the efforts to reduce greenhouse gas emissions, protect biodiversity resources, and manage international waters issues may prove even more challenging.

In the area of energy demand and CO<sub>2</sub> emissions, the World Energy Council has developed an “Ecologically Driven” scenario that results in only a 30 percent increase in world energy demand by 2020 and only a 5 percent increase in annual CO<sub>2</sub> emissions over 1990 levels. To get to that point requires:

- A rate of reduction in energy intensity far in excess of anything achieved historically.
- A very low increase in energy demand in developing countries.
- Programs to accelerate development and use of new renewables and natural gas, which would bear most of the burden of demand expansion.

An ecologically driven scenario for water demand over the next few decades would pose similar policy challenges. For example, governments would doubtless have to reduce subsidies to water users, greatly improve the integration of water management at the national level, decentralize water-supply services and provide a greater role for the private sector and water-user associations, promote joint management of watersheds by local communities and governments, and support the introduction of water-efficient technologies.

Making a commitment to move in the direction of such scenarios presents many challenges, not the least of which is convincing the political community and the general public that such actions are necessary.

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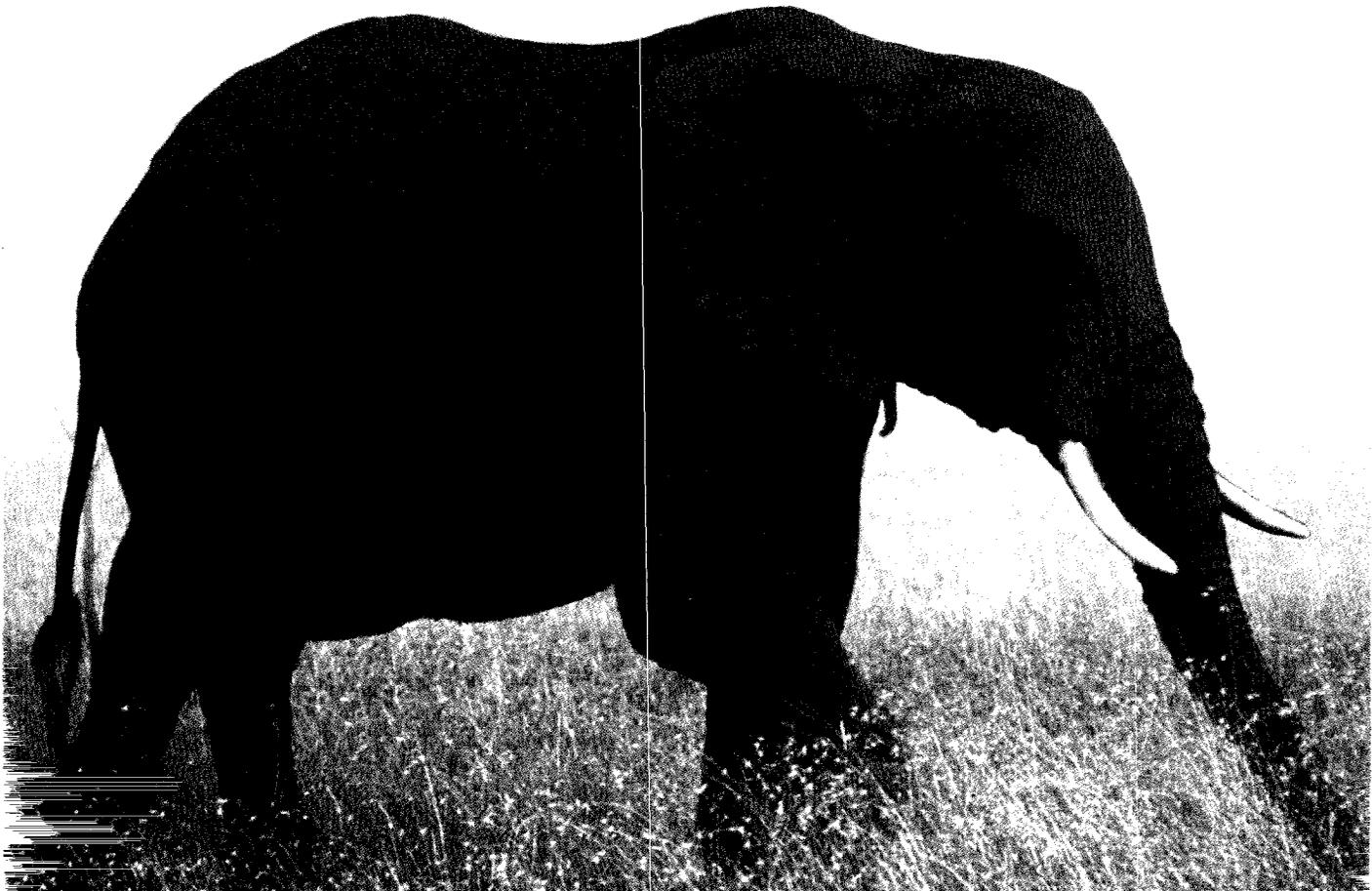
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*Governments can encourage communities to restore degraded ecosystems*



# ACTING LOCALLY & GLOBALLY: PARTNERSHIPS WITH A FUTURE

In countless ways personal and professional, people play a role in furthering sustainable development.

Parents and teachers set an example by conserving resources and investing their time – and that of the next generation – in learning about and protecting the environment. Voters force political leaders to invest in human and natural capital, including education, health, and environmental protection. Consumers pressure governments and businesses to make policies and production more sustainable. Watchdogs insist on getting information about existing practices that may adversely affect them or their environment. Local leaders collaborate with governments and the private sector to make decisions that protect their community and environment. Executives and entrepreneurs play a leadership role in implementing sustainable practices and policies.

The opportunities for people to play such roles may vary within and across nations, depending on the level of development and education, transparency of information, support for popular and community participation, cultural norms, and other factors. In virtually every case, however, people can have an impact.

The possibilities are greatly multiplied when governments and international institutions such as the Global Environment Facility actively try to foster development simply by bringing people into the process. Governments can initiate policies that make development more participatory and equitable; involve all stakeholders in decision making at the local level, particularly in natural resources management; provide more opportunities for low

income people to enter the formal economy; encourage communities to get involved in the restoration of degraded ecosystems; improve incentives for people to manage resources sustainably; use information technology as an aid to awareness raising; and encourage NGOs to play a more active role in development.

The recent emergence of democratic political systems in many regions and interest in decentralizing government authority provide many new opportunities for the growth of environmental citizenship. Many national constitutions now acknowledge individual rights to a clean and healthy environment. Increasingly, environmental NGOs and communities are encouraged to be accountable partners in sustainable development projects.

Businesses are taking a more active role in policy development and environmental management, based in part on the increasing realization that changing production practices to reduce waste and pollution can be economically sound. Governments are working as partners and facilitators with the private sector to encourage creative, cost-effective solutions to environmental problems. Voluntary codes of conduct and similar initiatives offer new avenues for change. Political reform and the rapid spread of global telecommunications provide many new opportunities to share information. NGOs are using the new telecommunications infrastructure to share information and build networks that cross hemispheric borders.



## Stakeholder Solutions

Many developing countries are experimenting with conservation initiatives that more actively involve affected communities as stakeholders.

One of the most promising is Zimbabwe's Communal Areas Management Programme for Indigenous Resources, or CAMPFIRE program. Starting in June 1991, communities were given the

responsibility to manage their water, grazing, timber, and wildlife resources. Each community was given direct responsibility for managing and harvesting their wildlife. In turn, the communities also received about 90 percent of the benefits provided by wildlife-related goods and services. In the village of Chikwarakwara, for example, the community decided to use the income from wildlife management to finish the local school, build a cooperatively managed grinding mill, and pay out the remaining money to individual households.

By shifting management authority and benefits to local communities, the CAMPFIRE program created strong new incentives for local communities to protect their wildlife resources and manage them on a sustainable basis. Though retaining ultimate authority over wildlife resources on communal lands, Zimbabwe's Wildlife Department was flexible enough to change its role from that of manager to facilitator and adviser to local communities.

In Papua New Guinea, the government has established "wildlife management areas" and sought voluntary agreements with local communities on wildlife management. Committees composed of local and government representatives have instituted royalties for the taking of deer, ducks, and fish by outsiders; a prohibition on the collection of crocodile eggs; bans on the use of fish poisons and commercially manufactured nets; and restrictions on hunting and logging.

Many governments also are turning to the private sector and NGOs for help in wildlife management. In Zambia, the National Parks and Wildlife Service has offered 25 prime national park sites to the private sector through competitive tender leases. South Africa's National Parks Trust has negotiated with the private Conservation Corporation for the management of the Ngala Game Reserve. The corporation also recently received a contract to operate tourist activities in 14,000 hectares of the Kruger National Park. Fees paid to the park are used for wildlife management, research, educational programs, and projects in the adjacent community.

In Indonesia, the private, nonprofit Leuser International Foundation has a seven-year renewable "conservation concession" for a contiguous area that includes the 905,000-hectare Gunung Leuser National Park, 505,000 hectares of Protection Forest, and 380,000 hectares of Production Forest. The concession gives the foundation the right to manage and coordinate conservation and sustainable development activities within the ecosystem, with objectives and workplans subject to approval by the Ministry of Forestry.

The long-term objective of the effort is to transform the area into an expanded national park with multiple-use zoning. The European Union is providing a \$40.6 million grant (to be matched by \$22.5 million from the Indonesian government) to the foundation for its conservation activities. Under discussion is the idea of expanding the foundation's concession to include the right to sell the value of Gunung Leuser's carbon sequestration function in the event an international market develops under the aegis of the climate change convention.

In many developing countries, governments are giving greater legal recognition to NGOs to help manage protected areas. Many such initiatives are underway in Latin America, including:

- In Guatemala, the Fundacion Defensores de la Naturaleza has the authority for the management of the 236,000-hectare Sierra de las Minas Biosphere Reserve.
- In Bolivia, Fundacion Amigos de la Naturaleza has a 10-year management contract for the 927,000-hectare Noel Kempff Mercado National Park, with responsibilities for hiring rangers, building infrastructure, and helping to reduce poaching.
- The Programme for Belize has management responsibility for the 92,000-hectare Rio Bravo Conservation and Management Area.

Governments have turned to NGOs to manage protected areas in other regions as well. For exam-

ple, the King Mahendra Trust for Nature Conservation, a semi-autonomous, non-governmental and nonprofit organization in Nepal, has been granted management responsibility for the 762,000-hectare Annapurna Conservation Area. Its autonomy enables it to manage with a relatively slim and flexible bureaucracy and to raise money directly from overseas organizations such as the World Wildlife Fund. Local residents are fully involved in planning and management of the area, which is supported by entrance fees charged to tourists.

There are also many examples of local communities instituting their own conservation measures, often based on traditional resource management practices. In Indonesia, many fishing villages have established a form of marine protected area called *petuanang*. The *petuanang* has certain closed seasons and permits only certain types of fishing techniques and fishing gear. In Peru, local residents are taking action to protect the Tamshiyacu-Tahuayo Communal Reserve, including limits on fishing technologies, and prohibitions on commercial fisheries and fish poisons.

## Information Tools People Need

Informing the public about environmental conditions can be a powerful instrument for improving environmental quality.

An important part of the U.S. effort to reduce toxic and hazardous waste has been the Toxics Release Inventory – a database on releases and transfers of over 650 chemicals from manufacturing plants. Industries must make information on hazardous chemicals available to state and local planning groups charged with developing emergency response plans for each community. More than 3,400 planning committees have been established to date. In combination with federal enforcement of statutory controls, the Toxics Release Inventory has been a striking success. From 1988 (the baseline year) to 1994, reported toxic releases dropped by 44 percent. The sharpest declines were to air and surface water.

# The Role of “Humanitarian Cities”

*Jaime Lerner*

Knowledge, resoluteness, and creativity could well constitute a comprehensive pact to reestablish harmony between man and nature, assuring good quality of life on the planet. This may sound somewhat whimsical, even childish, given the complexity that pervades environmental issues, and especially the conflicts inherent in economic activity. But there are reasons to hope for the best.

A quick glance at what has happened over the past few years enables us to count many victories. The greatest is the growing awareness about environmental issues, involving all levels of the population. Of the stale radicalism that characterized early environmental movements, very little is left. Today, what we have is a more rational view associated with improved knowledge and with a growing armament of technologies. And this is no trifling thing, even though in many regions problems have been increasing. What is important is that there is a growing global willingness to defy the problem, to change the present situation.

My experience as an urban planner and public administrator allows me to reiterate that local actions can promote global changes. And since a successful experience in one city is likely to reach the neighboring ones in a domino effect, we have the gratifying prospect of transforming entire regions, entire countries.

On the streets of my childhood, speckled with government offices, newspaper editorial rooms, and town houses – a mix of dwellings and small businesses – I understood that a city is a framework of life and work and that the more we mingle different activities and social ranks the more humanitarian it will be. Whenever one tried to keep economic activities apart from human settlements, the results were tragic.

Humanitarian and diversified cities can relieve important demands, such as transportation. Not only are the city’s environmental pressures reduced, but an interesting psychological base provided for

the exercise of solidarity – the essence of environmental motivation.

A city whose streets are the natural scene for socializing, instead of a place of fear and stress, will most certainly lead its people to healthier habits and feelings of greater good fellowship. In a city like this, it will always be easier for public authorities to summon people to adopt environmentally correct behavior.

In Curitiba, the city in which I was born, we started back in the 1970s an intense process of recovering green areas (going from a little over one square meter to fifty-two square meters per inhabitant), registering the city’s memory, turning streets into meeting points. People became participants in a major change which, in many aspects, improved everyone’s life. From then on, people became much more compliant when asked to avoid the irrational use of the car and separate organic from recyclable garbage, both at home and in their workplace.

And to this date, when someone asks me how to contribute to a better environment, I answer with confidence: “Separate your recyclable garbage, and use your car less.” It may seem insignificant. But what is important is to get the process going, to show people a feasible way, and not wait until we have all the answers before we start acting.

If a local government recovers a small valley bottom, changing what was once a problem for those who lived nearby into a spot of leisure and beauty, it will most certainly count on their compliance when it comes to more demanding challenges. And this is the logic of building a collaborative and mindful environment that may help to enforce stricter laws, and to bring about new technologies and greater investments from the government and private sector.

The experience of Curitiba, which served as a reference for other cities in Brazil and abroad, is now being extended to most of the 399 cities in the state of Paraná, which I have had the honor to govern for three years. In addition to intensifying mechanisms to support local authorities and creating environmental awareness in schools, we have strongly

insisted on the potential of small actions and simple attitudes. More than 150 cities have already adhered to the practice of separating recyclable garbage, and more than 60 are involving children and adolescents in valley bottom preservation.

By involving people in problem solving, we are able to multiply the number of supporters of the environment. Tomorrow, those children will be the rulers of their city, region, or country. This is in essence what the local administration can do: develop a sense of commitment, of shared responsibility – springing from an early start, from the simplest attitudes.

*Jaime Lerner was mayor of Curitiba, Brazil three times and is the present Governor of the State of Paraná.*



The Indonesian government has experimented with a program for rating and publicly disclosing the environmental performance of Indonesian factories. Poor performers were given a red code, while black was reserved for factories causing serious damage. Results in July 1997 showed that, among the 187 companies involved since the beginning, compliance improved from 35 to 49 percent.

Several factors appear to be contributing to the program's success. Companies with substantial foreign investment tended to be somewhat more sensitive about the ratings. Some companies with poor ratings also encountered a negative reaction from financial institutions and difficulty in entering the capital market, which prompted a quick improvement in their environmental performance. Some sectors, such as textiles, rapidly improved their rates to comply with client demand for products without negative environmental impacts.

Eco-labeling is another valuable type of information disclosure. It is widely used in developed countries and has also been introduced in some developing countries.

In 1996, the Philippines government started an eco-labeling program with some 2,000 companies in 23 industry associations. The EcoWatch Project employs a five-color grading system (gold, blue, green, brown, and black) to rate the environmental performance of these firms. A black label is used for firms with no pollution control or those causing serious environmental damage, blue for firms that meet all environmental standards and required procedures, and gold for firms that meet environmental standards for three years in a row and conduct at least two environmental programs, such as waste reduction and recycling.

Rating results will be announced in the media, so that low-rated firms will have a strong incentive to improve. Industry participation in the design of the project was critical to winning business community support for implementation of the project

and its expansion throughout the country.

At the international level, a potentially significant variation on eco-labeling is the development of timber certification programs, in which third parties certify that specific forests are being sustainably managed.

In 1994, the Forest Stewardship Council (FSC) – a coalition of NGOs, industry representatives, scientists, and indigenous peoples – adopted a set of principles and criteria for the sustainable management of forests, as well as guidelines on certified forest products. In 1995, FSC developed a rigorous framework for the evaluation, accreditation, and monitoring of organizations that issue certification claims in the marketplace, along with guidelines for regional forest management standards and a protocol for endorsing national certification initiatives. National certification programs based on the FSC guidelines are under development in more than a dozen countries, including Brazil, Sweden, and Indonesia.

Under this approach, independent, third-party certifiers are asked by companies to conduct on-the-ground evaluations to determine if forestry programs are meeting FSC's sustainability guidelines.

The FSC approach has many strengths. It has wide environmental support, provides on-the-ground verification, and includes many stakeholders in the development of its standards.

## Public Participation

Public participation is a valuable and often indispensable component of development projects, both at the community level and at the national and international levels.

At the community level, participation can be a critical component in efforts to manage resources such as water more sustainably.

In Kenya, the communities of Murugi-

Mugumango and Ngorika are successfully running community-owned water utilities along commercial lines. Several factors have contributed to the success of these organizations. Both water societies received management training from NGOs and technical assistance for construction design and supervision from the Ministry of Water Development. These organizations also worked with both water societies to develop a set of rules, bylaws, and guidelines, and a commercial framework based on paying for water.

Member-created rules have fostered ownership and responsibility for the water system. Members are required to contribute some labor as a partial payment for fees. Both communities have strict rules regarding nonpayment of fees or illegal connection to the water system.

The water societies are flourishing, with expanded systems and operations, new offices and staff, and widening distribution.

In Senegal, a 1990 World Bank-assisted irrigation project required total transfer of operation and maintenance to farmers as a precondition for financing rehabilitation works. Before the transfer, assessed fees covered only 17 to 21 percent of maintenance and replacement costs, and less than a quarter of those were actually collected. After the transfer, farmers paid fees that were four times as high, covering full operation and maintenance costs and a replacement fund. The system is much more reliable, electricity requirements were reduced by half, and the government saved money as farmers took over functions and reduced agency staff costs.

Bringing members of a community together to talk about the future also can be a valuable form of public participation. In the United States, the city of Chattanooga, Tennessee, held a Vision 2000 Project in 1984 that brought together 1,700 members of the community to talk about their vision of the city in the year 2000. The gathering came up with 34 goals that generated some 223 city pro-

jects, including construction of the Tennessee River Park and the Tennessee Aquarium. By 1992, 85 percent of the goals had been met. Over \$700 million has been invested in the city, about two thirds from private sources.

## New Roles for NGOs

Many governments are recognizing that NGOs can be an effective way to build new bridges with local communities in the management of natural resources.

In the Philippines, an umbrella NGO organization – the NGO for Integrated Protected Areas, or NIPA – has received a \$17 million GEF grant to help integrate other NGOs into the management of protected areas at the national and local levels. The project is taking place at 10 priority protected areas in the Philippines. NIPA has helped establish Protected Area management boards (with representatives from local governments, NGOs, and indigenous groups) and has recruited local NGOs to assist with field activities and community organizing.

The effort is helping to build community awareness of the need for conservation and sustainable development, though some administrative problems have cropped up that are similar to those that hinder government efforts, including multiple layers of management and a reluctance by NIPA to make decisions that might jeopardize relationships with local NGOs.

In India, the Development Alternatives Group works with manufacturers and academics to develop new technologies that will help meet the basic needs of poor rural people in India. DA licenses the technologies to enterprises to develop useful products at affordable prices. For example, DA has helped develop fuel-efficient, low-emission cook-stoves; a modern handloom; a hand-made paper production process that saves water and uses urban and rural wastes; mudblock processes that can substitute for steel and cement in rural construction; and a roof tile made of local materials.

DA estimates that, since its inception in 1983, it has created about 100,000 jobs or income opportunities, at an initial investment cost of about \$2,000 per job.

## MOBILIZING THE GLOBAL COMMUNITY

The empowerment of people at the local level – as individuals, as members of communities, as members of NGOs – is a heartening and significant development, offering new opportunities for implementing creative new approaches to sustainable development.

At the same time, local responses to environmental problems, no matter how effective, are inevitably inadequate when those problems are global in nature and can only be solved through global action. The challenge is to bring the multitude of players in this newly democratizing, market-oriented, culturally diverse world to work together to solve global environmental problems.

On many fronts, there are encouraging signs that new global communities – of business leaders, NGO leaders, scientists – are emerging to grapple with the complex new world of global environmental problems.

## New Business Leadership

Especially since the 1992 Rio Earth Summit, many international business leaders have taken leadership roles in urging the business community to be more environmentally responsible.

For example, the World Business Council on Sustainable Development is a coalition of more than 120 international companies from 36 countries representing more than 20 major industrial sectors.

The Council has identified seven core elements of eco-efficiency:

# Being Accountable to Each Other

*Her Majesty Queen Noor of Jordan*

In order to meet the environmental challenges of the new millennium, we must first examine the progress we have already made. For an entire generation now, since the 1960s, environmental activists have moved from documenting problems and raising awareness to researching and beginning to apply solutions. By necessity, these solutions have involved increasing social education and political mobilization, in order to put in place long-term corrective and preventive measures based on changing the habits of people and organizations.

The environmental movement has progressed in two distinct directions in that time. Geographically, from its birth in North America and Western Europe, it is now spreading south and east, as developing nations begin to realize the dangers of unchecked industrialization. Although the problems in each hemisphere vary, they complement each other to create a planet-wide threat. Many of the techniques that Northern activists applied in the 1970s, such as legal action, NGO activity, community education, and encouraging private corporate responsibility, are now being used in the South to increase awareness and correct environmental damage.

Analytically, the movement has seen a quantum shift, from very specific responses to local phenomena, such as mercury in lakes, urban air pollution, or degraded aquifers, to a much wider examination of the links among different problems. It has expanded to address national, regional, and now global problems, such as climate change, biodiversity, international waters, and ozone depletion. Even if the direct impact of a problem is local – a polluted river in South Asia or an expanding desert in the Middle East, for example – its consequences are ultimately felt around the world, through mega-urbanization, rural depopulation, emigration, and trans-national crime.

The emerging global awareness, combining many different areas of analysis – geographical, technical, public vs. private sector – shows us the way forward into the 21st century. It is imperative that we

weave all these different strands together into a more integrated appreciation of how people and environments either protect one another in a symbiotic relationship, or damage one another in a cycle of neglect, exploitation, and decay.

The major challenge that remains now is to mobilize people and institutions, locally, nationally and globally, to make the political decisions required to achieve three long-term goals: responsibility, accountability, and sustainability.

- Responsibility requires that everyone, at every level – personal, household, neighborhood, city, country, region, and world – acknowledge the impact of their actions on the environment, and modify their behavior accordingly.
- Accountability requires that those in positions of official or communal responsibility, such as government, business, and cultural leaders, diligently protect the environment through every means at their disposal, and that they be made to answer to their communities if they do not. Globally, accountability demands that states stop invoking short-sighted national interests to pursue damaging policies, and recognize that we are all now accountable to one another for our future well-being.
- Sustainability is the sum total of the above factors, combined with built-in monitoring systems that prevent further damage and ensure long-term environmental well-being.

The costs of a lack of political will and action are grave. We are already witnessing well-off fortress societies in pockets in the North and South alike, surrounded by landscapes of increasing devastation. Such divisions based on disparities in economic and natural resources, coupled with massive global urbanization, threaten the fundamental principles on which society has been built since urban life began five millennia ago.

Appropriate policy and market-based solutions for the next millennium must stem from a clear appreciation of why urban society has endured for so long and spread around the world from its Middle Eastern origins. Both our own ancient history and

our contemporary community-based development efforts suggest that stable societies rely on traditional decision-making structures that strike a balance between the dignity and rights of the individual and the responsibility and duties of leaders.

For example, Jordan's efforts at the Dana Wildlife Sanctuary (supported by the GEF) offer evidence of effective action at the local level, where environmental protection is integrated with income generation based on indigenous skills and cultural traditions. People become and remain active contributors to their societies when they feel that both their material well-being and their non-material human dignity are assured.

This assurance has always included some combination of three principles essential to the integrity of decision-making and development in any community: participation, pluralism, and again, accountability. To meet the environmental challenges of the 21st century, we must learn to apply on a global level the same participatory structures that smaller communities have used throughout history to give all members a stake in the outcome.

*H.M. Queen Noor was a recipient of the UNEP Global 500 Award for her activism in environmental protection.*



- Reduce the material intensity of goods and services.
- Reduce the energy intensity of goods and services.
- Reduce toxic dispersion.
- Enhance recycling of materials.
- Maximize sustainable use of renewable resources.
- Extend product durability.
- Increase the service intensity of goods and services.

Groups such as these are trying to think more creatively about the entire cycle of resource extraction, production, disposal, and waste. Many companies are looking at waste as a commodity to be sold or recycled. Examples include a process for using furnace slag in the manufacturing of high-quality cement, which results in reduced energy consumption, conserved natural resources, and lower greenhouse gas emissions.

Many other companies are discovering ways to reduce the environmental impact of production processes. In addition to re-using waste products, the options include:

- Input substitution: using less toxic material or using materials with a longer service lifetime.
- Technology change: replacing technology or process sequence to increase resource efficiency and to minimize waste and emission rates.
- Equipment modification: changing existing equipment and utilities to run processes at higher resource efficiency and at lower waste and emission rates.
- Better process control: using working procedures, machine instructions, and process record keeping to run processes at higher efficiency and at lower waste and emission rates.
- Changes in product design: reducing resource use and waste and emission rates. For example, "super" refrigerators can increase resource efficiency by a factor of 10.

These opportunities are not exclusively in the

# Global Change and Food Security

Jacques Diouf

There are few images which touch our emotions more than people who suffer from hunger and malnutrition. They are 10 percent of the world's people, but we hear precious little about them. The Food and Agriculture Organization of the United Nations has dedicated itself to lead efforts to cut this number in half by the year 2015.

Lost days of work, reduced mental capacity, and increased vulnerability to illness dramatically reduce the ability of hungry people to engage in productive activities. This contributes to a continuing cycle of poverty often accompanied by environmental degradation.



About 16 percent of total arable land area has been degraded by human activity. Progressive loss of productive drylands, watershed degradation in mountain ecosystems, and conversion of coastal wetlands affect principally food insecure people on the economic margins of these areas. Moreover, as the human population grows, productive land per person is constantly diminishing.

The need for legal and institutional reforms that give land users incentives to manage their land on a sustainable basis is widely recognized. Initiatives such as the Global Plan of Action for Land-based Pollution take on increasing importance as a way to mitigate and avoid impacts that affect food production.

Technology transfer is another key. Food insecure people are compelled to mine the soil of its natural nutrients rather than retaining the necessary structure and fertility for sustained production. Integrated plant nutrition systems can go far towards maintaining soil nutrients at the required levels.

The scarcity of freshwater resources is recognized as a growing constraint. Less well known is that, on average, more than two thirds of freshwater consumption is for agriculture. Policy reform, especial-

ly as regards water pricing, conservation technologies, and greater emphasis on equity and distributional aspects, can go far in ensuring that freshwater is sustainably managed and that the poor benefit.

A number of forces have contributed to the loss of agricultural biodiversity – which comprises a wide range of “managed” plant and animal species and ecosystems. Loss of natural habitat is one factor, but the use of high-yield varieties (HYVs) has also contributed; nearly 30 percent of livestock breeds are near the point of extinction. Ironically, without HYVs the world would not have met the food challenges of the last 30 years.

Several global initiatives are already under way – the Global Plan of Action for Plant Genetic Resources and the Global Strategy for Farm Animal Genetic Resources – but they require more support. A further requirement is to link in situ conservation, including that of wild species, with ex situ conservation of plant, animal, and fish genetic resources. The development and promotion of sustainable farming systems can be an important entry point. Local and indigenous knowledge and practices must also be tapped.

It is generally agreed that tropical countries, most of which are in developing regions, will be the most severely affected by the potential effects of climate change. The current impacts of El Niño may be indicative of the challenges that lie ahead.

For modern societies, energy production and consumption concerns focus on CO<sub>2</sub> emissions, pollution, and possible climate change; for rural people of developing countries, the energy-environment linkage centers on poverty, low agricultural productivity, and low real incomes. The challenge is to transform the energy intensity and mix of technologies in wealthy countries, and to increase the supply of energy in developing countries through appropriate combinations of fossil and renewable sources.

The Global Environment Facility has accomplished much in its short history. However, I am cognizant of the urgent need to forge closer links with issues that confront the world's poor. The Global

Terrestrial Observing System (GTOS) is an important new collaborative effort which seeks to bring the power of science to bear on issues such as those mentioned above.

FAO's experience has been that market-based solutions seldom benefit the rural poor unless they are designed with this group in mind from the outset. Many resources have limited market value but serve as important sources of food, fiber, or fuel in the lives of poor people. How then might we calculate the "global increment" of agro-biodiversity conservation, or land and water conservation, or the simple energy requirements upon which humankind depends?

Informed readers will surely note that what FAO calls for - protecting and rehabilitating the global environment for the food insecure - does not present significant technical challenges. I think they will also agree that the cost of inaction will be continued environmental degradation, hunger, and malnutrition - a situation we are morally obliged to prevent.

*Jacques Diouf is Director-General of the Food and Agriculture Organization of the United Nations.*



domain of large multinational companies. The UNEP Industry and Environment Office has compiled examples of cleaner production in many developing countries, including: reduced waste generation in sugar milling and refining in the Philippines; fewer toxic wastes in leather tanning in Tunisia; better treatment of wastewater in the rubber industry in Malaysia; and reduced chrome discharge in the bicycle wheel plating process in China.

## New Scientific Leadership

On several critical environmental issues, scientists in recent years have mobilized impressive international efforts to develop global assessments and put the weight of the global scientific community behind those assessments.

For example, the Global Assessment of Soil Degradation was sponsored by UNEP and coordinated by the International Soil Reference and Information Centre in the Netherlands. Project directors asked more than 250 soil scientists and 21 regional coordinators for their expert estimates of the degree, type, and causes of the human-induced soil degradation that has occurred since World War II. These estimates were subsequently mapped and the map was digitized and accompanied by summary tables and thematic maps. This was the first baseline study using a consistent methodology to estimate global soil degradation.

Subsequent to the negotiations for the Convention on Biological Diversity, UNEP launched a Global Biodiversity Assessment that was intended to provide a baseline for current knowledge about biodiversity. With funding from the Global Environment Facility, some 300 experts from 50 countries were assembled in 13 teams, each with up to four coordinators and several lead or contributing authors. Each team met in one or more workshops to exchange views and plan the detailed content of each chapter of the report. The draft was extensively peer reviewed and governments were kept closely informed. Some 50 gov-

# A Window in Time

Nafis Sadik

The size and distribution of human populations will help to determine the course of the next century. In many countries, smaller families and a higher proportion of working-age adults in the population will offer opportunities for faster economic growth and poverty alleviation. Slower population growth overall offers societies a breathing space, a window of time in which to make choices about protecting natural resources.

One of our main responsibilities toward coming generations is deciding how big those generations will be, by deciding the size and spacing of our families. Each of us has the right to make that decision; we share the responsibility of ensuring that everyone can make it.

Women in most developing countries want to have fewer children than their mothers did. If they can make their own choices, one result will be smaller, healthier families and slower population growth. Enabling women especially to make informed choices about their sexual and reproductive lives means ensuring that they have equal rights and full access to education; that a full range of reproductive health services is universally accessible; and that families and communities support the right to choose. Crucially, it means enlisting the active support and involvement of men.

Ninety-six per cent of population growth is in developing countries. Although fertility is falling in all developing regions, world population is still growing by over 80 million people a year, and will pass 6 billion in 1999. The United Nations estimated that there will be between 7.7 and 11 billion people by 2050, with the "most likely" projection at 9.4 billion. That is, world population will probably increase by a third in the next half-century; and it could almost double.

Population-related issues are linked to sustainable development in a number of ways. Increasing demand for land and water resources is holding back development in a growing number of coun-

tries. The world's forests and the wealth of global species are under attack. Climate change threatens to raise sea levels, spread pests and diseases, and reduce yields. Urbanization and industrial development are eating up arable land, and increasing pollution is threatening health. Continuing poverty, (accompanied by illiteracy and poor health) holds back countries and communities and, in the absence of conservation technology, increases environmental stress.

At the same time, the possibilities for successfully meeting this challenge have never been greater. The comprehensive new approach to sustainable development puts a strong emphasis on human development, alleviation of poverty, improvement of women's status, and guarantee of their rights. There is widespread agreement on the need for:

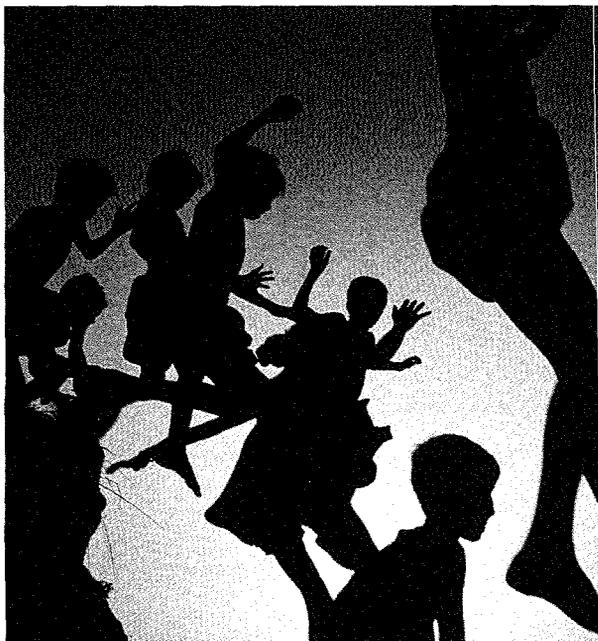
- Universal access to quality reproductive health services.
- Women's full participation at all levels of decision making about health, reproductive health, and the environment.
- Capacity building to ensure full integration of population concerns into development and environment policies, plans, and programmes at all levels.
- Effective research, information, education, and communication about the links between population, environment, and sustainable development.
- Inclusion of demographic trends and factors in global analyses of sustainable development issues.
- Provision of adequate resources for the task. Needs were estimated at \$17 billion annually by the year 2000, including \$5.7 billion in international assistance.

The most important link of all is for policy makers to recognize that reproductive rights and women's rights, along with wider improvements in basic health and education, can make a formidable contribution to sustainable development.

For this contribution to be realized, it is crucial that the programmes of the Earth Summit and the 1994 International Conference on Population and Development are fully implemented and funded. Progress is being made – many countries are now working towards universal access to primary and reproductive health services. Policies are being put in place which recognize that women must be educated and empowered, supported in their crucial roles, and given the full recognition they deserve. The understanding is growing that men have to be involved in and committed to these changes – which in the long run will benefit men just as much as women.

Reproductive rights and women's rights are human rights. They should be pursued vigorously for their own sake. But they are also a vital component of sustainable development, by easing environmental pressure and helping to create the conditions for sustainable economic growth. This is a case where doing what is practical is also doing what is right.

*Nafis Sadik is Executive Director of the United Nations Population Fund.*



ernments nominated experts to review the report, and altogether more than 1,100 experts from more than 80 nations participated in the peer review process.

The most noteworthy example of new scientific leadership is the Intergovernmental Panel on Climate Change, established by UNEP and the World Meteorological Organization in 1988. This effort brought together more than 2,500 scientists in three working groups to study the science of climate change, adaptation and mitigation, and other issues.

With the publication of two widely publicized assessments, the IPCC has become the leading authority on the state of the science of climate change and will continue to play a role in the climate change debate. It has also produced a number of technical papers, including reports on the use of simple climate models, regional climate change scenarios for impact assessments, and the calculation of carbon dioxide emission pathways leading to a stabilization of atmospheric concentrations. The next full assessment will be published in 2000.

## New Political Leadership

Around the world, a great deal of time and effort is being spent thinking about the complexities of sustainable development and how the theory translates into practical policies.

The Earth Summit's Agenda 21 report found a need for an institutional arrangement at the national level where a wide variety of governmental and non-governmental interest groups could meet to discuss policies and strategies that favor sustainable development. In response, some 50 nations have created National Councils for Sustainable Development to serve as a new national-level body.

National Councils for Sustainable Development represent a potentially significant opportunity to

# Consumption Prospects

Two forces – population and consumption – are the fundamental drivers affecting global environmental conditions. Population matters, because each individual adds to the global requirements for food, water, shelter, and other basic human needs. Personal consumption also matters, since individuals with large amounts of disposable income can add significant demands on global resources and the global environment. As global wealth increases, so too does the potential impact of consumption on the global environment.

The consumption issue is partly one of equity between developed and developing nations. Comparing the United States and India on a per capita basis in 1991, for example, shows that the average American consumed about 33 times more aluminum, 45 times more iron ore, 15 times more steel, 57 times more phosphate rock, 42 times more petroleum, and 385 times more pulpwood than the average Indian.

The disparity in motor vehicle ownership is equally striking. In the United States in 1993, there were an estimated 561 passenger cars per 1,000 population; in the rest of the industrialized nations belonging to the Organisation for Economic Co-operation and Development, there were 366 cars per 1,000. In the developing world, the comparable numbers are 1.48 in China, 3.1 in South Asia, 14.2 in Africa, 28.9 in East Asia and the Pacific (excluding China and Japan), and 67.9 in Latin America and the Caribbean (Fig. 2.1).

With recent changes in economic systems and surging economic growth in many developing nations, there are many signs of rapidly rising per capita consumption in developing nations. Car ownership, while continuing to rise in OECD nations, is expected to rise at a much faster pace in developing nations. Growth is expected to be particularly dramatic in ownership of two- and three-wheel vehicles in developing nations such as China and India.

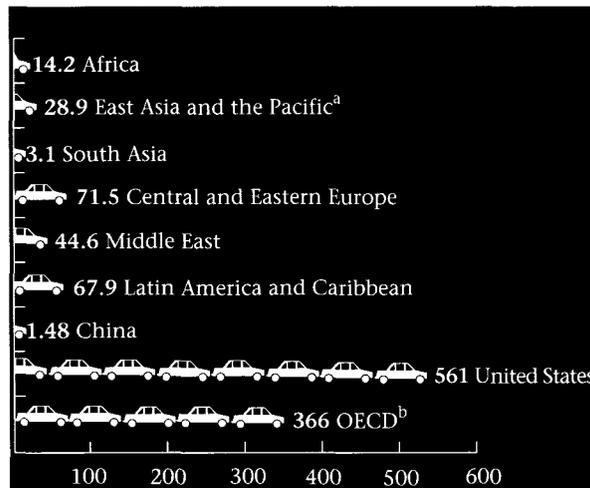
In India, motorcycle ownership is rising by 17 percent per year. Consumption by the highest-income group of machine-based household appliances, electricity, and petroleum products accounts for about 75 percent of the total consumption for these commodities in India.

What do such trends portend for the global environment?

Rising vehicular ownership could mean greater congestion, energy consumption, and air pollution. In the United States, for example, transportation sources account for 77 percent of carbon monoxide emissions, 45 percent of nitrogen oxides, 36 percent of volatile organic compounds, and 22 percent of particulates.

Worldwide energy use in the transportation sector is expected to grow by about 2.7 percent annually, faster than industry or other sectors. Without substantial investments in vehicular pollution control devices, this is likely to mean a considerable increase in air pollution in developing countries, especially in urban areas.

2.1 Passenger Cars per 1,000 Population, 1993



Source: WRI 1996

Notes: a. Excluding China and Japan

b. Excluding the United States

bring together representatives of national governments, business leaders, non-governmental organizations, labor, academia, scientists, women, and other groups to help resolve conflicts and build consensus for sustainable development.

The success of these groups in integrating sustainable development into decision-making varies from country to country depending on their mandate, composition, and character. Some NCSDs focus only on environmental issues, while others are government coordinating bodies with broad representation from other sectors.

Since NCSDs are neither executive nor legislative bodies, divided decisions simply replicate the disputes that divide society as a whole and are of limited value. Decisions made by divided vote tend to amplify the historical conflicts between members of NCSDs and thus reduce incentives for accommodation. Though slower and more difficult, NCSDs seem to be most effective when they operate by consensus, building agreement among members and looking for agreements that can persuade others to act.

To grow, NCSDs need to build capacity in a number of areas, including information dissemination; training; the design and implementation of operational structures; networking and communication between NCSDs; strategic planning and participatory consultation workshops; the creation of expert panels to provide technical information; and logistical support, equipment, and materials.

In theory, national councils could provide an infrastructure both for regional and international cooperation. They could conduct research on regional issues and institutions, and could provide an important source of information and ideas for the meetings of the United Nations Commission on Sustainable Development. They could also serve as a conduit of information about experiences at the local level.

## New International Instruments

Time and again over the past few decades, the global community has responded to emerging global environmental problems with unprecedented international agreements – notably the Montreal Protocol, the Framework Convention on Climate Change, the Convention on Biological Diversity, the Convention to Combat Desertification, and many others.

In the course of crafting this new family of global agreements, many important lessons have been learned.

As the experience with the Montreal Protocol shows, the scientific community can play a crucial role in two ways: first, confirming the links between human activities and global environmental problems; and second, showing what could happen to human health and the global environment if nothing is done.

When the evidence is in hand, an international consensus to act can emerge quickly. The same process is underway in the current international debate on climate change, but the process has been more difficult because the linkages between human activities and global environmental impacts are more complex and still not completely understood. Nevertheless, a global consensus for action is emerging.

Another important lesson learned has to do with the structure of international agreements, and the elements that can contribute to an effective one. In the case of the Montreal Protocol, the agreement was not punitive and favored incentives and results-oriented approaches. All nations participated in the agreement, but at different levels of responsibility in recognition of their differing conditions. The Kyoto Protocol to the Climate Change Convention has benefited from the experience with the Montreal Protocol and is including many of the same elements.

A third vital lesson is that, to the extent possible, every interested party must have an opportunity to participate as full partners in the process and voice their concerns. It is particularly helpful for environmental advocacy groups and the business community to be part of this process. International agreements need to provide incentives to foster public-private partnerships, to accommodate different interests and concerns, and to provide a role for business leaders to seek innovative technical solutions.

A fourth lesson concerns the role of governments in implementing these conventions. Government actions need to be consistent and predictable, provide sufficient lead times, favor government-led incentives over direct industry subsidies, and use flexible, market-based solutions where they are appropriate.

Finally, a fifth lesson is that agreements mark the beginning of a process, not the end. Scientists and NGOs must continue to further global understanding of environmental problems and communicate what they have learned to the public and policy makers. Policy makers, in turn, must be flexible and respond to changing circumstances with new or modified policy solutions.

## Lessons from the GEF

The Global Environment Facility and its implementing agencies – the United Nations Environment Programme, United Nations Development Programme, and the World Bank – have actively worked for many years to encourage public participation and stakeholder involvement in projects. In the course of this effort, many lessons have been learned.

Three aspects of public involvement are particularly crucial: information sharing, public consultation in the preparation and implementation of projects, and stakeholder participation in projects.

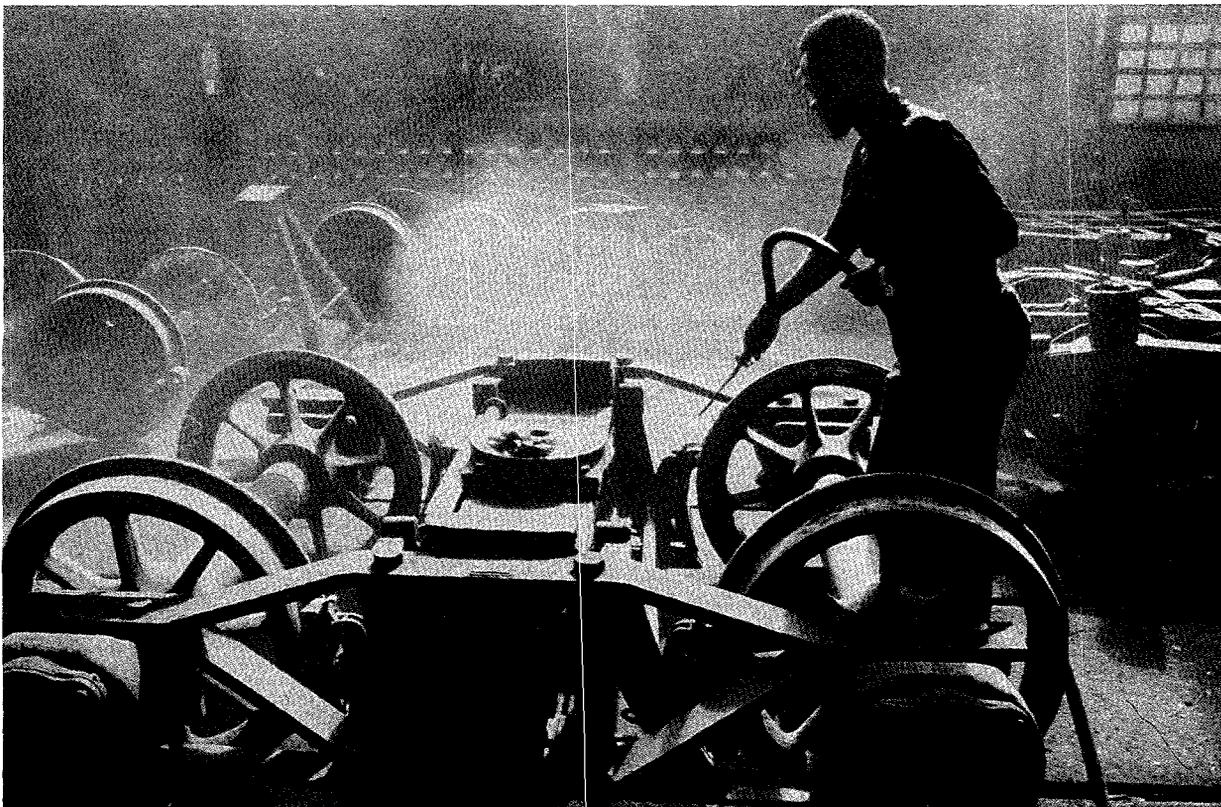
In the area of information sharing, there are numerous opportunities to obtain information about GEF-financed projects. The GEF has a home page on the World Wide Web ([www.gefweb.org](http://www.gefweb.org)) as do its implementing agencies. In addition to the names of focal points in 161 participating countries, the GEF home page contains links to others maintained by the Convention on Biological Diversity, Framework Convention on Climate Change, Convention to Combat Desertification, Ozone Secretariat, and the UN Commission on Sustainable Development.

Public consultations, which focus on an exchange of ideas, also are a widely used tool in GEF-financed projects. In the Papua New Guinea National Conservation and Resource Management Project, for example, GEF supported consultative national workshops held in collaboration with six international and four national NGOs. Journalists for the Environment in Tanzania also received funding to organize national workshops for an East African biodiversity protection project.

Stakeholder groups are involved in GEF-financed projects in a variety of ways, ranging from direct participation in project decision-making and management to indirect involvement through subcontracting of one or more project activities or informal participation. In the Nepal Biodiversity Conservation Project, for example, one international and two local NGOs administer 73 percent of the project's funds.

Some projects set up multisectoral project steering committees to share management responsibilities for a project, which formalizes the role of stakeholder groups in project decision-making. For example, NGOs are included on the project steering committee in a greenhouse gas reduction project in Chile.

Intermediary NGOs often have the specialized skills and experience to provide links between community-level institutions on the one hand and national and international institutions such as the



*Businesses of all sizes can reduce the environmental impact of production processes*

GEF on the other. They can facilitate communications between project beneficiaries and government; help to identify and voice community needs; support participation and group formation; train and build the capacity of community groups; and channel resources to the community level.

Experience provides some clear lessons about what works and what does not work in community-based development. There are some fundamental prerequisites, including the reversal of control and accountability from central authorities to the community level; ensuring that projects respond to community needs and that incentives for participation are in place; and ensuring that community groups own and enforce their own rules.

When the institutional framework is right, community-based development projects actually cost less than conventional programs and are quicker to implement. Once the participatory process is established, the benefits include increased efficiency and cost-effectiveness. Furthermore, when the success of projects depends heavily on changes in

behavior at the community level, promoting participation may be the only means of meeting objectives.

Community participation can yield significant results. In Gujarat, India, in the 1980s, forest offenses were occurring at the rate of 18,000 cases annually and assaults and murders of forestry officials were frequent. To help end these conflicts, a community-based joint forestry management project was established. The project included community meetings, widely publicized creation of forest protection committees, and a profit-sharing plan on timber returns to local groups.

As a result of these changes, conflicts between officials and community groups diminished, community groups assumed responsibility for patrolling forests, and returns to villages from forest resources increased sharply.

In Côte d'Ivoire, a national rural water supply program established community water groups to maintain 13,500 water points. Under the new sys-



tem, breakdown rates were reduced from 50 percent to 11 percent at one third the cost. The program required taking away responsibility for rural water supply from the sectoral agency, supporting private sector involvement in spare parts distribution, retraining technicians, and signing contracts with village groups and the water directorate. The results were sustained in those villages with high demand for the rehabilitated water point and where well-functioning community organizations already existed.

The full participation of both men and women can be crucial to successful community-based projects, yet participation by women is often impeded by cultural and legal constraints and by women's relative lack of time and mobility due to their workload and multiple roles.

A variety of practical measures can facilitate participation by women. In a World Bank-financed urban development project in Togo, for example, initial meetings with community leaders included no women. The project leaders suggested holding a separate meeting where the women could articulate their priorities. At the instigation of the chief's wife, about 50 women attended the meeting. Their concerns differed considerably from those of the men, and were incorporated into the project design.

Many other strategic measures can help overcome these systemic biases, including legal reforms granting women full rights to land tenure and ownership (in a project in Honduras); incentives to encourage more girls to enroll in secondary schools (in Bangladesh); and efforts to make government agencies more accountable to women (in El Salvador).

Participation is not a panacea and, like all approaches, has its limits. In the forestry sector, for example, participatory approaches have not worked in some areas because of conflicts over forest resources, dispersed population structure, or the history of forest patterns and use. At the national level, there may be powerful interests or prejudices against reforming forest policies and devolving authority to a broader range of forest users. At the local level, forest communities are often unorganized and lack the capacity to manage large forest areas. In addition, there may be conflicting interests among local groups that make reaching a consensus difficult.

In many cases, however, encouraging participation by key stakeholders, devolving authority and improving community incentives, and taking advantage of the skills of intermediary NGOs can greatly improve the odds that projects will succeed.

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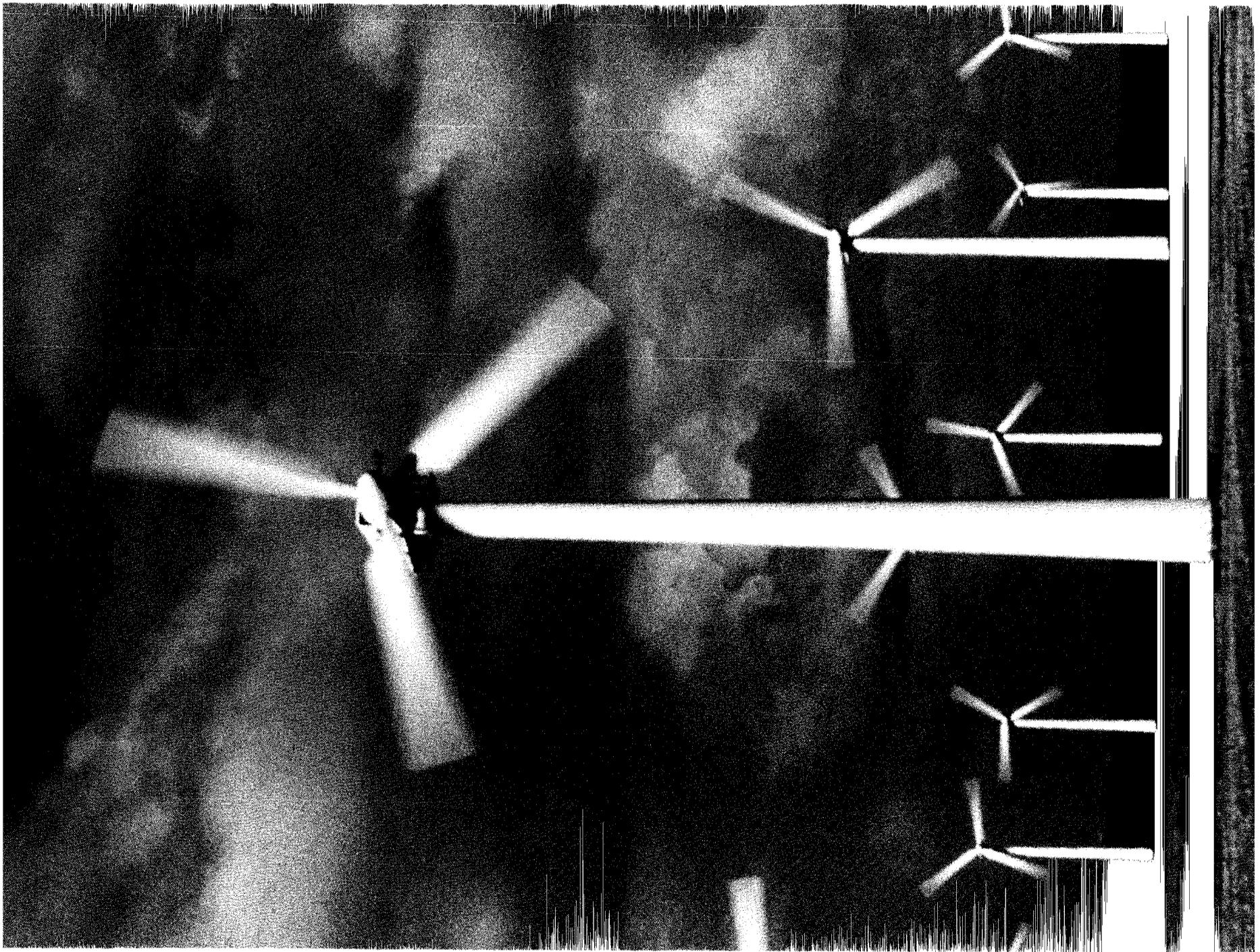
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# FOSTERING SUSTAINABLE ENTERPRISE IN THE GLOBAL MARKETPLACE

Of the many elements that contribute to sustainable development, certainly one is to improve the quality of life for the least-advantaged people living today. Another is to protect the quality of life for future generations. A healthy environment is vital to both.

A monumental challenge facing the world is to foster economic development that supports these goals: a better life for the least-advantaged and for future generations, and the healthier global environment critical to sustaining life, today and in the future.

UNDP's *Human Development Report* argues that economic growth cannot be "voiceless" – that the poor must share in the benefits of future economic expansion. In that light, "good" economic growth generates full employment and security of livelihoods; fosters freedom and empowerment; distributes benefits equitably; promotes social cohesion and cooperation; and safeguards future human development.

To promote this kind of growth, the report stresses strategies that maximize job creation; promote greater participation, empowerment, and democracy; reduce poverty; nurture and enhance diverse cultural traditions; encourage families to invest in education; promote government spending on education, health care, social security, water supply and sanitation; and increase access to productive assets such as land, credit, and physical infrastructure.

*Windpower: accelerating the transition to sustainable energy technologies*

Future generations, and the global environment itself, are often without a voice in public debate. From an environmental perspective, "good" economic growth might be characterized by stronger incentives to:

- Carefully husband and replenish renewable resources.
- Better understand both the human and environmental impacts of development.
- Reduce and/or prevent pollution.
- Use energy and materials more efficiently.
- Address long-term environmental problems such as climate change and biodiversity loss.

Nudging economic growth in these directions presents many difficult challenges. Capitalism has relatively short time horizons, so it is difficult to justify investments that anticipate developments more than about 15 years in the future. Many pressing global environmental problems lie outside conventional economic activity. Overcoming these challenges requires creative policymaking and the active participation of governments, institutions, and concerned citizens.

Can market systems be fine-tuned to redirect economic growth to support human development and protect the global environment? That question is addressed in the rest of this chapter.

## Market-Based Policies

Over the past decade or more there has been considerable rethinking about the best ways to meet environmental and resource protection goals. Several answers have emerged. One is to reform environmental and resource policies to be more

flexible and take better advantage of the inherent dynamics of market systems. Another is to identify those areas where the market fails to capture environmental externalities and to develop remedies.

In both cases, the development of these policies provides important new opportunities for governments and civil society. For governments, market-based policy reform provides an opportunity to reduce direct government costs and improve the cost-effectiveness of environmental protection programs. For communities and NGOs, it is an opportunity to ensure that market-based policies accelerate the transition to sustainable development and serve the interests of all citizens, including women, indigenous groups, and the poor.

**3.1 Environmentally Damaging Subsidies mid-1990s**  
(billions of U.S. dollars per year)

| Sector or Product | Developing and Transition Economies |
|-------------------|-------------------------------------|
| Fossil Fuels      | 48                                  |
| Electricity       | 112                                 |
| Road Transport    | 16                                  |
| Water             | 56                                  |
| Agriculture       | 10                                  |
| <b>Total</b>      | <b>242</b>                          |

Source: Gandhi et al. 1997

Market-based policy reform also presents an opportunity for international institutions. Many governments are uncomfortable with market mechanisms. International bodies can support demonstration projects, community participation, information exchange, and a variety of other initiatives that broaden support for equitable market-based policy reform.

To date, most of these market-based policies have been implemented in developed nations and in some rapidly growing developing nations. In virtually all cases, they have been introduced as supplements to, not substitutes for, traditional government regulations.

Implementing market-based policies is not easy in any nation. To succeed, they optimally require open, dynamic market systems, sound macroeconomic conditions, political and institutional stability, and full development of human rights.

In developing nations with large informal sectors, other policies – capacity-building, overall policy reform, community participation, investments in education and health care, etc. – initially may be more effective than market-based mechanisms.

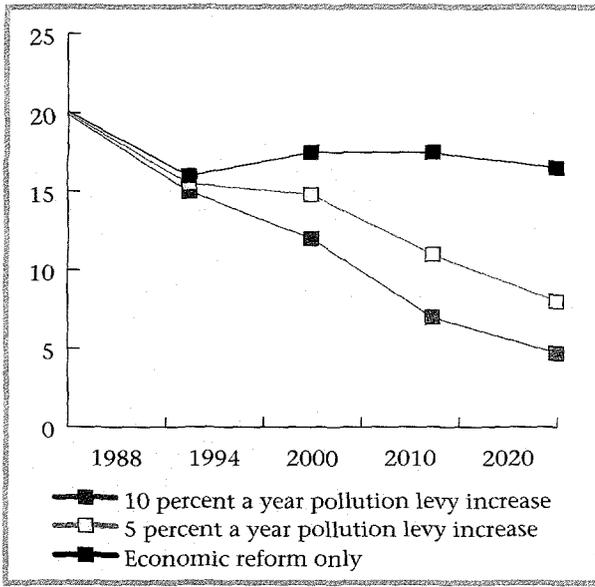
Nevertheless, market-based policies may offer valuable opportunities to achieve environmental goals more efficiently and at lower cost to governments and entrepreneurs. They also offer opportunities for governments to ride the momentum of economic growth, while leading it to a more sustainable footing.

Market-based instruments acknowledge the fact that environmental resources are often underpriced. First, subsidies – on water, electricity, fossil fuels, road transport, and agriculture – are an incentive to overuse a resource; reducing or removing subsidies creates an incentive to use resources more efficiently. Second, market prices only reflect private costs, not the external damages caused by pollution or resource extraction. Instead of inflexible, top-down government directives, market-based policies take advantage of price signals and give entrepreneurs the freedom to choose the solution most economically efficient for them.

There are several varieties of market-based instruments: subsidy reduction, environmental taxes, user fees, performance bond and deposit/refund schemes, and targeted subsidies.

**Subsidy reduction.** Most nations are moving towards reduction of subsidies in many areas, bringing the cost of delivering resources such as water and electricity much closer to market cost. Nevertheless, estimated subsidies for energy, roads, water, and agriculture in developing and transition economies still totaled about \$242 billion annual-

**3.2 Total Suspended Particulates in China (millions of tons)**



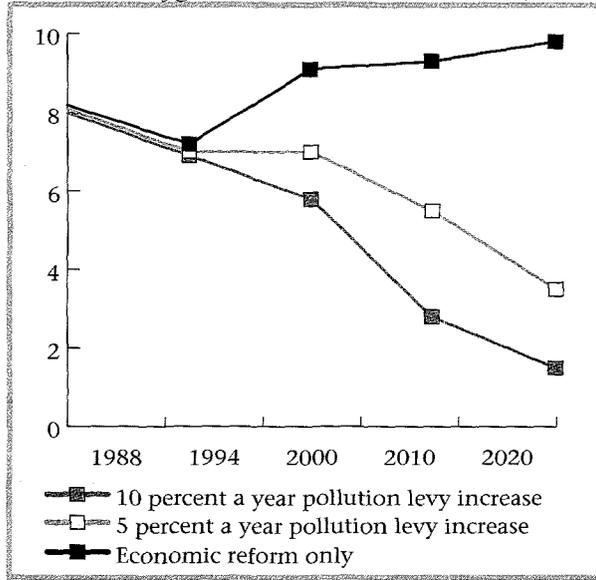
Source: World Bank 1997

ly in the mid-1990s (Fig. 3.1). Subsidies in developed countries also are massive; a recent OECD report estimated total transfers to farmers from governments and consumers at \$336 billion in 1995.

Once established, resource subsidies are understandably difficult to dislodge. But experience suggests that subsidies can be reduced or removed without disrupting rural economic development. By 1978, the Bangladesh government was paying \$93 million (in 1995 dollars) to subsidize roughly half the costs of fertilizer to farmers. A gradual deregulation of urea sales, completed in 1983, yielded savings equal to 2 percent of total government revenue. Real prices of urea declined due to improved efficiency in distribution, increased domestic production, and decreases in world urea prices in the mid-1980s. Declining prices, together with an increase in the area planted to improved varieties, resulted in a sustained increase in fertilizer use in Bangladesh.

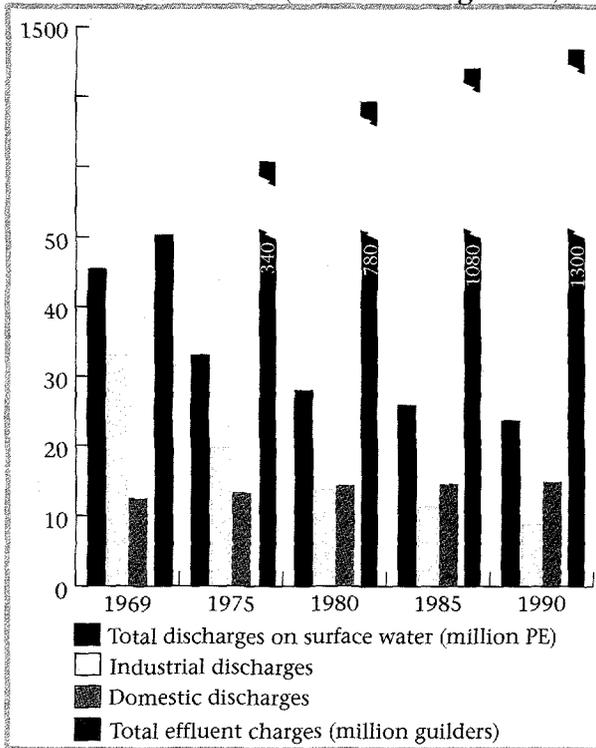
In China, subsidy rates for coal declined from an estimated 61 percent in 1984 to 11 percent in 1995. Private mines now account for about half of

**3.3 China's Pollutant Emissions from Regulated Enterprises Under Three Scenarios. (Chemical oxygen demand in millions of tons)**



Source: World Bank 1997

**3.4 The Netherlands: Effluent Charges on Industrial Wastewater (million Dutch guilders)**



Note: "Population equivalent" (PE) is roughly equivalent to the water pollution emissions by one individual or 60g biological oxygen demand per day.

Source: World Bank 1997

# The Costs of “Business as Usual”

*Sir Martin Holdgate*

Global environmental change is the outcome of billions of individual actions, operating within the context of millions of local communities. Some form part of the formal economy, others do not. Their contribution to global environmental problems varies greatly. No policy for the global environment can work unless the complex mosaic of local societies and actions is understood.

One thing is certain: the need to improve the quality of life of over one billion people who are the world's poor. Throughout virtually the whole of Africa, most of Asia, and a large part of Latin America, “business as usual” would be socially intolerable.

There is a pressing need to inter-relate global models of socioeconomic development with global environmental models like those provided by the Intergovernmental Panel on Climate Change. The implications of worldwide economic growth based on ever-mounting use of fossil fuel energy have been pointed out. But their global models are hampered by the difficulty of disaggregating them so that implications can be judged at local and national levels.

It may well be true that “business as usual” will lead to a global increase in mean temperature of as much as 2 degrees Celsius in a century, but unless more is understood of the impacts on ocean circulation, precipitation regimes, and the incidence of storms it will be hard to convince communities of the need to adjust development policies. The consequence of rising sea level is clearest: a rise of 20-30 cm spells uninhabitability for many small atolls and poses a hard choice between abandonment and costly engineered protection for many mainland coasts.

Biodiversity will be reduced on virtually any scenario. In theory, improved agriculture on the world's most fertile land could feed 8 to 10 billion people adequately – but there is a mis-match between the distribution of people, wealth, and fertile soils, and social pressures in many regions are

certain to drive communities to cultivate second-rate land unsustainably. There will be more forest clearance for agriculture and short-term commercial gain from timber. Universal human travel, and associated transportation of plants and animals (both in commerce and inadvertently) will erode the biogeographical barriers that have separated genotypes and allowed evolution to create regionally distinctive forms, most notably on oceanic islands.

As to how much biodiversity will be lost – it is guesswork. But I guess from 10 to 20 percent of species living on land over the next century. Will it matter? The Earth has lost up to 80 percent of its diversity in past ‘extinction spasms’, and evolution has more than made good the loss. The productivity, biomass, and capacity to maintain biogeochemical cycles in relatively impoverished ecosystems like temperate forests is only a little inferior to that of diverse ones like tropical forests. So while the losses will be tragic, they should not be catastrophic.

Putting an economic cost on such changes is almost impossible, because our capacity to substitute human environmental management for the natural processes we currently treat as ‘free goods’ is largely unproven. But where the options are clear – as in coastlands threatened by sea level rise – the economic costs would be enormous.

It is also evident that the poorest communities already lack the economic strength to ensure their development even under stable environmental conditions, so how can they meet the added costs of unpredictable environmental change? The more the world's climate systems are driven out of the range to which human societies and our supportive ecosystems are accustomed, and the more biodiversity is impoverished, the greater the costs of compensating human management are certain to be.

The role of governments is fivefold:

- Negotiate and enforce global agreements such as firm targets for reducing greenhouse gas emissions and curbing avoidable waste of biodiversity.
- Collaborate to share technical skills and provide economic assistance to communities with the greatest problems and the least resources.

- Create conditions favorable to sustainable development, through integrated resource management and social development which support sustainable economic growth and population stability.
- Encourage good science that will enhance understanding of global change, and help develop more cost-effective policies.
- Adopt market-based solutions which rest on the sound valuation of natural resources and their inclusion in economic equations, and use economic instruments (including fiscal and pricing mechanisms) effectively.

Intergovernmental organizations have a major role to play in catalyzing these actions, especially the interchange of knowledge and development of common approaches. Non-governmental institutions do as well, in encouraging effective action on the ground and continually pressing governments to live up to agreements reached at the Earth Summit.

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all production and some 80 percent of the coal is now sold at international prices. These reforms have had numerous benefits. Energy intensity in China has fallen by about 50 percent since 1980, operating losses at state-owned mines dropped from \$1.4 billion to \$230 million over the 1990-94 period, and the government's total subsidy for fossil fuels fell from about \$25 billion in 1990/91 to \$10 billion in 1995/96.

Land use subsidies also can create perverse incentives. In France, since the mid-19th century, a tax on undeveloped land had encouraged conversion of environmentally sensitive woodlands and wetlands. Under reforms introduced in 1992, this tax has been reduced and the economic incentive to convert less productive natural areas into productive lands decreased.

**Environmental taxes.** Environmental taxes have the double advantage of generating revenues and sending a strong signal to cut emissions and more efficiently use resources.

Many German states have adopted similar water tax policies since 1988. These policies are still linked to traditional regulation, since they are generally levied only in cases where a permit or license is required and are usually set by the same agencies responsible for granting licenses. Because of the relatively weak relationship between changes in prices and use, differentiated water taxes alone are not expected to cause dramatic reductions. But they can provide an incentive to change water extraction patterns. For example, many German states impose water taxes only on groundwater as an incentive to substitute surface water for groundwater.

In China, a pollution-levy system is intended to raise revenue for investment in industrial pollution control, help pay for regulatory activities, and encourage enterprises to comply with emission and effluent standards. The system imposes non-compliance fees on discharges that exceed standards, and fines and other charges assessed on vio-

# Determining Nature's Value

Andres M. Sada

It has been a quarter century since the concept of sustainable development came into vogue and particularly so after the Rio Summit. This concept envisions economic growth continuing with natural resources maintained in such a way that successive generations can prosper. The concept consists of two objectives which have often been considered impossible to attain simultaneously. But mankind must find a way to do so if we are to survive.

Development is an obvious necessity if we consider the income level of a majority of the world's population; that is, even if we believe that the developed world need not develop anymore, at least 3 billion people today and many more in the future have a long way to go before they reach an acceptable level of income.

On the other hand, development cannot occur if we lose the world's biodiversity and all the ecological processes and services that ecosystems and nature provide to mankind. It follows, then, that development and conservation are both necessary.

At the moment, however, we do not know how to achieve sustainable development. Those interested in development assume that growth must continue even if it means the loss of biodiversity. Those interested in conservation believe that development must not occur where it implies the loss of biodiversity. Both believe that their position is to be held until a way is found to accomplish both objectives simultaneously.

We must accept that the conservation of non-renewable resources is impossible in the long term. Many industries are making great and successful efforts at diminishing their required inputs. In some cases, they are being required to accept discarded older models of their products for recycling. This, I believe, will turn out to be economically advantageous and will result in a very substantial decrease in the use of virgin resources, but not the total elim-

ination of their use. Necessarily then, exhaustion of some non-renewable resources will eventually happen.

Some time in the next century solar energy will likely replace combustion as the main source of energy. Then the increase of carbon dioxide in the atmosphere will stop and fossil fuels will last, perhaps, for several centuries.



For renewable natural resources the story is different. A possible solution lies in the following thought: if we were to find in rain forests valuable products in addition to those presently exploited we could reach a point where the standing forest becomes more valuable to the "campesino" than slash and burn, and, assuming also the existence of property rights, the continued loss of rain forests would stop. It is quite possible that rain forests contain,

because of their diversity, much more of value than is presently being exploited. But can we apply the same concept to other ecosystems, other situations? It seems much more difficult to believe that desert biodiversity could become of sufficient economic value to assure its protection by its owners or users. And, what about the sea?

The idea of including natural resources in national accounts is beginning to take hold. We are starting to realize that there are things which our present economic system does not value and, therefore, does not take into account. Certainly from the point of view of business – which is almost to say from the point of view of the economy – biodiversity and the services provided by Nature have no value, because they do not take part in production processes, they are not tradable, and because few attempts have been made at determining economic consequences of their loss.

But just as we now accept that externalities such as pollution and generation of garbage must be internalized for the economy to operate properly – and these externalities are now being countered by taxes and tradable permits – if we are going to succeed at

sustainable development we must determine the value of the loss of biodiversity and nature's services and internalize them.

But as in the case of the "campesino" who would protect the forest because it is in his economic benefit, we must reach a point where sustainable development becomes the most attractive economic alternative. This will require an enormous effort to explore, research, and determine the value of biodiversity and, particularly, the value of ecological processes and nature's services.

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lations of levy regulations. Local environmental protection bureaus retain 20 percent of the fees to support administrative and monitoring activities, while the rest is used for grants and low-interest loans for pollution control projects.

Government revenues from the pollution levy have increased rapidly, from 1.2 billion yuan in 1986 to 2.7 billion yuan in 1993. Subsidized loans from the levy fund and similar programs have also created incentives to control pollution, providing about 15 percent of all capital expenditures for pollution control.

The system has been faulted on several fronts. Fees are generally lower than the marginal cost of abatement, so many industrial enterprises choose not to comply. The charges also are not indexed for inflation, further eroding their effectiveness. Furthermore, levies are based only on the pollutant that exceeds its standard by the greatest amount, rather than on all the pollutants that exceed their standards; assessed only on above-standard emissions, so there is no incentive for firms to reduce emissions below the standard; and based on pollutant concentrations rather than on total discharges to the environment. Tightening China's pollution levy system could be an effective way to reduce air and water pollution over the next few decades.

An analysis of what might happen over the 1997-2020 period in five Chinese cities looked at three different scenarios: business-as-usual, 5 percent annual increases in air and water pollution levies, and 10 percent annual increases. Under the 5 percent scenario, chemical oxygen demand discharges would fall by more than half, sulfur dioxide emissions by a third, and particulates by half. Under the 10 percent scenario, sulfur dioxide and particulate emissions would each fall by three quarters (Figs. 3.2 and 3.3, p. 45).

In the Netherlands, a system of effluent charges on industrial wastewater has been remarkably successful. Especially among larger companies, the



levy worked as an incentive to reduce pollution. In a survey of 150 larger companies, about two thirds said the levy was the main factor in their decision to reduce discharges (Figure 3.4, p. 45). As the volume of pollution from industrial sources dropped, rates were increased to cover the fixed costs of sewage water treatment plants. Rising rates are providing a further incentive for more companies to start purifying their sewage water.

Because of the high cost of continuously measuring discharges, only large firms are regularly monitored. As a result, smaller companies and private households are charged a fixed fee, which has greatly reduced incentives for lowering discharges in these groups. Total discharges to surface water in the Netherlands fell by roughly one half from 1969 to 1990, but those reductions were entirely from industry. Domestic discharges have actually increased over this period.

In the United States, the state of Iowa passed a groundwater protection law in 1987 imposing taxes on fertilizers and fees to manufacturers and dealers in agricultural pesticides. The taxes themselves are not expected to have much impact on

consumption of fertilizer and pesticides, but about two thirds of the revenue is used for a variety of education, demonstration, and technical assistance programs to show farmers how to reduce the use of agro-chemicals and maintain yields. The program has already achieved significant results, measured both in terms of changes in attitudes and levels of agro-chemical use. This approach suggests that the effectiveness of taxes and price signals can be enhanced by educational programs that show people they have choices.

The government of Sweden imposes a substantial tax on the sulfur content of fuels (more than \$4 per kilogram), but provides a rebate to large emitters who can show how much sulfur they have abated. For large emitters, the effect is the same as an emissions tax; for others, the charge provides an incentive to switch to low-sulfur fuels and reduce energy use. The tax is simple to administer – costs have been less than 1 percent of revenue – and it has produced extensive fuel switching and emissions reductions, enabling Sweden to reach its target for sulfur emissions several years ahead of schedule.

**Credits and tax incentives.** Many countries offer subsidized credit and tax relief for environmentally related investments. They cover areas such as abatement investment or clean technology adoption, reforestation activities, mercury emission controls, cleaner energy uses, and the phase-out of ozone-depleting substances.

Tax credits have succeeded in several nations. Tax relief has been an important factor driving reforestation activities in Chile. In Barbados and Ecuador, tax incentives have successfully fostered adoption of cleaner energy technologies (Fig. 3.5).

In Latin America, tax incentives for pollution abatement have been somewhat less successful. According to one study, the lack of effective environmental monitoring and enforcement has weakened incentives for firms to participate.

*User fees.* User fees can provide a substantial source of revenue, a useful incentive for more efficient use of a resource, or send signals about current patterns of consumption.

In Brazil, the state of Minas Gerais levies a forest products charge indexed to the value of each type of product. Under this approach, charges for charcoal and firewood from native forests, which are major causes of deforestation, are much higher than for other forest products. Up to half of the charge is waived if reforestation is sufficient to offset consumption levels.

Fees on timber production have often been relatively small compared to its value, providing little incentive to harvest efficiently. The Philippines government recently raised the charge on each cubic meter of timber from 1 percent to 25 percent of the market price. Such a charge should provide a significant incentive for logging companies to invest in improved harvesting methods.

The Indonesian government imposes a reforestation fee of about \$22 per cubic meter on all timber extraction. The fee has generated more than \$1 billion to support reforestation and conservation activities.

Visitor fees for the use of parks and conservation areas also can provide a source of revenue to upgrade park facilities or finance other conservation activities. Since 1994, the Costa Rican government has imposed higher park entrance fees for foreign visitors. Initially controversial, the new pricing structure has since been adjusted and is funding upgraded facilities.

*Performance bond/deposit-refund systems.* Some nations – including Indonesia, Malaysia, and Costa Rica – use performance bonds to ensure that reforestation takes place after timber harvesting.

The United States also has used this kind of approach to ensure that strip-mined lands are reclaimed. Before a mining permit can be granted, a company must post a performance bond sufficient to cover the cost of reclaiming the site in the event the company does not complete reclamation. The bond is not fully released until all performance standards have been met and full reclamation of the site (including permanent revegetation) is successful – a five-year period in the East and Midwest and 10 years in the arid West. The bond can be partially released as various phases of reclamation are successfully completed.

### 3.5 Credit and Tax Incentives in Latin America and the Caribbean

|           | Credit Subsidies  | Taxation/Tariff Relief  |
|-----------|---|---|
| Barbados  | To defray costs of environmental technologies in the tourism sector | Income tax rebate for water conservation and solar energy use in the tourism sector |
| Brazil    | For abatement investments in the industrial sector                  | Income and value added tax rebates for clean technology adoption                    |
| Chile     |   | For forestry activities   |
| Colombia  | For abatement investments in the industrial sector                  | Income and value added tax rebates for abatement investments                        |
| Ecuador   | For investments in mercury recovery in artisanal mining             | For investments in mercury recovery in artisanal mining                             |
| Jamaica   |   | For abatement investments in free zones   |
| Mexico    | For abatement investments in the industrial sector                  |   |
| Venezuela |   | For abatement investments in the industrial sector                                  |

Source: World Bank 1996

# What I Learned in the Rainforest

*Tachi Kiuchi*

When I visited the Malaysian rainforest, I learned what many already knew: saving the rainforest is a business opportunity. Creativity and technology can be used to substitute for the extraction of trees and resources.

But there was a more profound lesson for me as well. It is in the interest of business not merely to save the rainforest, but to emulate it. To operate like a living system is perhaps the most important and profitable challenge facing business today.

As business people, we have been looking at the rainforest all wrong. Its real value is not in the trees or pharmaceuticals. It is in the design and relationships. Rainforests are incredibly productive, more so than any business in the world. Even with very thin soil and few nutrients, rainforests are home to over two-thirds of the world's biodiversity. They maintain a dynamic stability while continually evolving into ever greater complexity. What company wouldn't be eager to learn from this design?

When we take trees from the forest, we can ruin its design. But when we take lessons from the forest, we further its purpose. Imagine how creative, productive, and ecologically benign commerce could be if companies understood the reasons behind the enduring success of the rainforest ecosystem.

In comparison to the rainforest, feedback systems in business are not well developed. At Mitsubishi Electric we want to know the full costs and benefits of every product, and the social and environmental needs we can help fulfill. Our priority is to create the world's best corporate feedback system.

**Get Feedback.** Our feedback systems have helped us downsize by cutting materials, not people. We are among the best in the world at minimizing the raw materials in our products, making us a leader in the compact electronics market. Feedback has also been critical for identifying profitable new markets and investments. It makes us aware of costs that other people have to pay; we aim to truly earn our profit by reducing those costs.

**Differentiate.** In the rainforest, conformity is death. If two organisms have the same niche, only one survives. The other either adapts, or dies. It's the same in today's economy. Most companies today are trying to be the one that survives, desperately seeking the lowest cost. We think it's smarter to adapt: create unique products, fill new niches, differentiate. We learned the hard way, when we could not sufficiently differentiate our standard televisions from the competition's and had to discontinue the product. Now, rather than kill or be killed by our competitors, we sidestep them by making our products distinctive first. Only then is it time to reduce costs.

**Cooperate.** Many people think competitiveness is the key to business success, but this strategy is out-of-date. In the old, undifferentiated economy, we all made the same products for the same markets. There was no choice but to compete. Today, Mitsubishi Electric increasingly finds profit in cooperative joint ventures. Each company retains its independence, specialty, and core competence. Like the rainforest species, together we benefit from our diversity.

An example is the creation of an air exchanger that both lowers energy costs and helps prevent "sick building" syndrome. A corporate communications feedback program alerted us to the opportunity. The local dealer, close to the customer, knew the market potential; we had the technologies that could meet the need. These joint marketing approaches and cooperative partnerships are now as vital to our future as our products.

**Be a Good Fit.** We once believed that the survival of the fittest permits only one winner. In the rainforest, there are many winners, and the same can be true in our economy. The question is not who is most fit, but where we best fit. If we solve a real problem, fulfill a real need – then we will fit, we will survive, and we will excel.

At Mitsubishi Electric, we don't simply run our business to earn profits. We earn profits to run our business. Our business has meaning and purpose, a reason to be.

This suggests the final lesson I've learned (so far) from the rainforest: the highest mission of business is to help fully develop the human ecosystem, sustainably like the rainforest, in all our diversity and complexity.

What I learned from the rainforest is easy to understand. We can use less, and have more. Consume less, and be more. It is the only way. For the interests of business and the interests of the environment are not incompatible. They are the Japanese omote and ura, the Chinese yin and yang, product and process, economy and ecology, mind and spirit – two halves.

Only together can we make the world whole.

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Deposit/refund schemes have been widely used to encourage recycling. In Japan, deposits are made for the return of bottles. The deposits are passed on from manufacturers to shops and ultimately consumers, who get the deposit refunded when the used packages and bottles are returned. Under this system, Japan recycled 92 percent of its beer bottles, 50 percent of waste paper, 43 percent of aluminum cans, and 48 percent of glass bottles. Figure 3.6 on page 58 provides some further examples of deposit/refund programs in Latin America.

**Targeted subsidies.** In the United States, the Department of Agriculture has since 1986 been operating a voluntary program under which farmers temporarily convert highly erodible and other environmentally sensitive cropland to soil-conserving uses, such as grass or trees. The government pays farmers an annual per-acre rent and half the cost of establishing a permanent land cover (usually grass or trees) in exchange for retiring highly erodible or environmentally sensitive land from production for 10-15 years.

By December 1996, 33 million acres were enrolled in the program at an average rental of \$49 per acre; for the latest signup in March 1997, enhanced competition and other factors helped reduce annual rental costs to about \$39 per acre. Erosion reduction was estimated at 626 million tons, or about 19 tons per acre – roughly a 20 percent reduction in cropland erosion compared with conditions prior to the program.

To enroll acres with the highest environmental benefits relative to government cost, bids are ranked according to an environmental benefits index. The index includes five factors, four characterizing the environmental contributions of each parcel offered and one characterizing the government cost of enrolling each parcel. The environmental factors include water quality protection, creation of wildlife habitat, control of soil erosion, and tree planting. Environmental priority bids, such as filter strips along waterways, are eli-

# Food Security and Agrobiodiversity

M.S. Swaminathan

In 1798, when the global population was about 960 million, Thomas Malthus wrote that "the period when the number of men surpasses their means of subsistence has long since arrived." Two hundred years later, there is enough food in the market for every one, although human numbers have increased sixfold. The hunger which afflicts over 800 million children, women, and men now is more due to lack of adequate purchasing power to buy food than to its availability.

The success achieved so far in keeping Malthusian predictions at bay is largely due to the intelligent use of agrobiodiversity for creating plant varieties which yield more under conditions of good soil fertility and water management and which possess tolerance or resistance to a wide range of biotic and abiotic stresses. The green revolution of the 1960s was triggered by the development of high yielding varieties or hybrids of rice, wheat, maize and other staple crops. In the case of rice and wheat, a quantum jump in yield potential was achieved by introducing genes of a semi-dwarf character. The commercial exploitation of hybrid vigor, first in maize in the United States, and later in many other crops including rice, sorghum, and millet, helped to increase the productivity of these crops substantially.

This revolution is now being supported by remarkable progress in molecular biology and genetic engineering. Molecular mapping techniques are helping to identify the location of genes controlling both qualitative and quantitative traits in chromosomes. Such advances in genetic improvement, supported by irrigation, soil and plant health management, and appropriate post-harvest technology provide hope for the future.

As we approach the new millennium, there are apprehensions that Malthusian predictions may yet come true. The major reasons are:

- Increasing population leads to diminishing per capita availability of arable land and irrigation water.
- Increasing purchasing power and urbanization

results in a greater demand for food, particularly for animal products.

- Desertification, deforestation, and other forms of environmental degradation undermine the ecological foundations essential for sustainable advances in agriculture.
- Inadequate efforts in the revitalization of the traditions of rural and tribal families in the area of in situ on-farm conservation of agrobiodiversity is resulting in the loss of valuable species and genes.
- Marine fish production has become stagnant.
- No major technological breakthroughs are on the horizon which can help overcome the fatigue of the green revolution in several parts of the world.

If we are to enter a millennium of hope on the food front, no time should be lost in initiating the following steps:

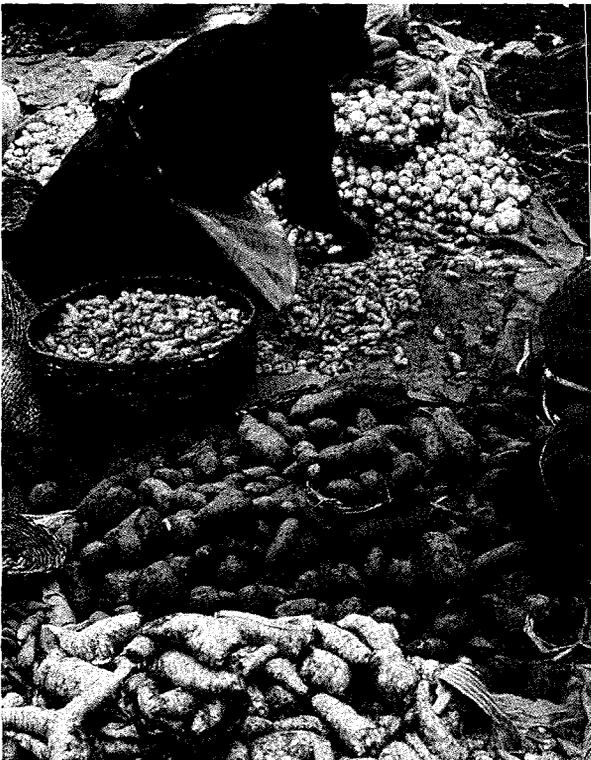
- Enlarge the food basket by including the excluded in terms of hundreds of crops which in the past helped to provide both food and health security.
- Enlarge the genetic diversity in cultivated crops; genetic homogeneity enhances genetic vulnerability to pests and diseases, as is evident from several serious famines during the last century associated with pest epidemics.
- Accelerate efforts in situ, ex situ and in situ on-farm conservation of biodiversity, so as to ensure that adequate genetic variability exists for the purpose of achieving the desired goals in genetic recombination and enhancement.
- Establish genetic enhancement centers which can provide to grass root level breeders novel genetic combinations of value in improving the productivity, profitability, stability, and sustainability of major farming systems.

It will be possible to produce more food and other agricultural commodities from the available land and water resources without associated ecological harm only if there is a mass movement for the con-

servation and sustainable and equitable use of genetic wealth in crop plants and farm animals, including fish. For example, wheat breeding efforts at the International Centre for Maize and Wheat Improvement have stressed the need for access to an increasing number of land races and folk varieties for use in hybridization programmes.

Much of agrobiodiversity, particularly at the intra-specific level, is conserved by tribal and rural women and men, through in situ on-farm methods. Their contributions are yet to be recognized and rewarded, although they are conserving valuable agrobiodiversity at personal cost for international and national public good. This is why there is much emphasis in the Convention on Biological Diversity on integrating consideration of equity in benefit sharing in the use of biodiversity. Equity in benefit sharing will help to generate an economic stake in the conservation of agrobiodiversity and thereby help to halt genetic erosion. This is a vital first step in achieving the human quest for a food secure world.

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gible for a 10 percent rental bonus and automatically receive maximum environmental factor scores. For two bids with the same environmental score, the bid with the lower per-acre cost receives a higher ranking in both the national and state ranking plans.

The program is providing net social benefits (in present value over the life of the program) estimated at \$10-\$15 billion, including increased net farm income, the value of future timber, preservation of soil productivity, improved surface-water quality, lower damages due to windblown dust, improved waterfowl hunting, and nonconsumptive wildlife benefits. Social costs included higher food costs to consumers (\$3-\$8 billion) and the costs of establishing vegetative cover (\$2.4 billion). Net government costs are estimated at \$6-9 billion, including \$14.6 billion in program expenses (\$13 billion for rental payments) and commodity program cost savings of \$5-\$8 billion.

## Creating Markets

Several attempts are underway to create markets for environmental resources and services. The approaches include establishing property rights, privatization and decentralization, tradable permits and rights, and international offset systems.

**Property rights.** Establishing secure property rights over land, water, logging concessions, and biodiversity resources provides an incentive for better resource management. For example, there is still relatively little legal recognition of the customary rights of indigenous peoples to their ancestral lands. Many development programs affecting indigenous peoples must deal with the question of land tenure security and natural resource rights.

Indigenous groups, NGOs with legal expertise, and international institutions have been working with governments to clarify these issues. Clarifying such rights can strengthen community incentives to manage resources on a more sustainable basis.

For example, the West Bengal Joint Forestry Management Program in India has succeeded in incorporating the livelihood strategies of tribal women into the program. In most areas, the recognition of the rights of tribal women to collect and market sal and kendu leaves has been an important factor in the program's economic and institutional success. In addition to its potential for increasing employment and income-earning opportunities, the program to re-establish the productivity of sal forests also helps reduce soil erosion by protecting the upper ridge tracts where forests are located. Establishing indigenous people's property rights in nations with large areas of tropical forest could be an important prerequisite to the development of international offset programs that protect tropical forests in order to sequester carbon.

**Privatization/Decentralization.** Privatization and/or decentralization of public infrastructure and services can help improve efficiency and lower costs.

In Côte d'Ivoire, a private firm (SODECI) was granted the concession to provide water to the city of Abidjan over 30 years ago. Since then, the company has taken on lease arrangements to produce and distribute water in many other municipalities, and recently won a countrywide concession contract for water operations and investments. To facilitate service to the poor, SODECI waives hook-up charges on three out of four of its domestic connections. Low-income customers have proved to be very reliable; SODECI has a 98 percent collection rate from its private customers. The cost of water is comparable to that in neighboring countries with similar economic conditions, where water charges rarely cover the cost of operation and maintenance of the system.

In Phoenix, Arizona, city officials have successfully privatized a portion of the solid waste collection service. Under the program, solid waste collection services are split into four quadrants, with both private companies and the city allowed to partici-

pate in bidding for the right to collect solid waste in each quadrant. In order to keep a public sanitation workforce in place, the city sanitation service retains the right to collect waste in at least one city quadrant.

After losing the first two rounds of bids, the city has won the next three successive bids. The system has lowered costs, improved productivity, and provided an effective incentive for the introduction of new waste technology.

**Pollution trading programs.** Under an emissions trading program, a company that reduces emissions below the level required by law can receive emissions credits that can be used for higher emissions elsewhere. Companies can trade emissions among sources within a company as long as combined emissions stay within a specified limit. Companies also can trade emission credits with other companies that are sources of such emissions or save earned emission credits for future use or trade.

Under an effluent trading program, a polluter who reduces water pollution discharges below the minimum level required to meet water quality standards can sell excess pollution reductions to other dischargers within the same watershed. Effluent trading can allow dischargers to take advantage of economies of scale and the treatment efficiencies that vary from discharger to discharger, and it could provide an economic incentive for dischargers to go beyond minimum pollution reductions. Trading programs also could be established for other sources of water pollution, including non-point sources (e.g., runoff from farms) and indirect dischargers (companies whose wastewater is treated by a municipal sewage treatment plant).

In Santiago, efforts to control air pollution include a tradable permit system for large industrial fixed sources. The system allocates a maximum level of daily emissions from existing sources. Any emission above this limit must be compensated by the

reduction of emissions from some other source. Compensation cannot exceed one day and cannot be made across seasons.

In the U.S., an acid rain control trading program is designed to reduce emissions of sulfur dioxide and nitrogen oxides, the primary causes of acid rain. The law sets as its primary goal the reduction of annual SO<sub>2</sub> emissions by 10 million tons below 1980 levels in the year 2010. Affected utility units are allocated allowances based on their historic fuel consumption and a specific emissions rate. Each allowance permits a unit to emit one ton of SO<sub>2</sub> during or after a specified year. For each ton discharged in a given year, one allowance is retired and can no longer be used. Allowances may be bought, sold, or banked. In 1995, 5.3 million allowances were deducted, which represents 61 percent of all 1995 allowances issued. During Phase II, the Clean Air Act sets a cap of 8.95 million allowances for total annual allowance allocations to utilities. This cap will ensure that environmental benefits will be achieved and maintained.

The cost of reducing a ton of SO<sub>2</sub> from the utility sector continues to decline: scrubber costs have dropped about 40 percent below 1989 levels, removal efficiencies have improved from about 90 to 92 percent in 1988 to about 95 percent or more in new retrofits, and expected increases in cost associated with the increased use of low sulfur coal have not materialized. These reductions in cost are being reflected in allowance prices, which have dropped from \$150 per ton in 1994 to a range of \$70-\$115 per ton in 1996 and 1997.

**International offsets.** International offset systems permit firms and institutions to meet environmental objectives by purchasing abatement anywhere on the globe, thus reducing global emissions at the least cost. One of the most significant efforts to use international offsets is the Climate Change Convention's joint implementation program, discussed later in this chapter.



**Regulations.** The array of market-based regulations includes fees and charges, standards, quotas, and bans.

Charge systems are fairly widely used in developing countries and transition economies for the control of waste and emissions.

In Malaysia, for example, effluent charges have been used to control water pollution from the palm oil and rubber industries. In the case of palm oil, effluent standards and other conditions are attached to each mill's license. In addition to standards, effluent related discharge fees are levied on the concentration of biochemical oxygen demand (BOD) in the effluent. Over time, the mills were required to reduce BOD concentrations, first to 5,000 mg/l in 1978/79, and then to 500 mg/l by 1981, 250 mg/l in 1982, and finally 100 mg/l in 1984. By 1991, out of 112 mills monitored, 75 percent were in compliance with the 100 mg/l discharge standard (Fig. 3.7, p. 59).

The government waived some or all of the effluent charges for mills that were conducting research on

### 3.6 Market Based Instruments and Solid Waste Management in Latin America and the Caribbean

|                  | Deposit-Refund System   | Solid Waste Levy and Tipping Fees                                     |
|------------------|---|---|
| <b>Barbados</b>  | Voluntary for glass beverage containers on consumers  | Tipping fees under introduction                                       |
| <b>Brazil</b>    | Voluntary for glass and aluminum beverage containers on consumers                                       | Flat fees   |
| <b>Chile</b>     | Voluntary for glass and plastic beverage containers on consumers  | Flat fees. Tipping fees under discussion                              |
| <b>Colombia</b>  | Voluntary for glass beverage containers on consumers  | Electricity surcharge   |
| <b>Ecuador</b>   | Voluntary for glass beverage containers on consumers  | Flat fees paid by municipality  |
| <b>Jamaica</b>   | Voluntary for glass beverage containers on consumers  | Flat fees   |
| <b>Mexico</b>    | Voluntary for glass beverage containers on consumers and compulsory on car batteries at wholesale level | Flat fees. Levy and tipping fees for hazardous waste under discussion |
| <b>Venezuela</b> | Voluntary for glass beverage containers on consumers  | Flat fees   |

Source: World Bank 1996

innovative treatment technologies. Mills that succeeded in developing technologies to reduce BOD were rewarded with a reduction in the effluent-related license fees.

The palm oil industry did incur additional costs in connection with the pollution control regulations, but most were ultimately borne by oil-palm growers, who had no outlet for palm oil fruits aside from sales to the palm oil mills. Thus, the industry's competitiveness was unaffected by the regulation, and it continued to expand even as regulations became more stringent.

Charge and quota systems also are widely used to help control urban traffic congestion. In Singapore, a program that charges drivers for using roads in the city center during peak hours resulted in a 73 percent reduction in traffic in the restricted zone. In New York, the number of taxis is controlled through a system of tradable licenses. In Santiago, the right of access to key roads for buses and taxis is auctioned.

Charging higher fees for visits to national parks also is being tried in many developing countries. Galapagos National Park generated direct revenues of \$3.7 million in 1995, with the park keeping about one third of the receipts and the rest earmarked for protected areas on the mainland of Ecuador. Divers spend about \$30 million annually at the Bonaire Marine Park in the Netherlands Antilles and over \$100 million in Caribbean protected areas generally.

In offshore fisheries, several countries are using individual transferable quotas (ITQs) to manage fishery resources. In New Zealand, a limited number of ITQ "owners" are given the right to harvest a certain level of fish, with the actual amount depending on fish stock assessments for each species. Fishers with ITQs have the right to harvest the fish or to sell or trade their quota.

In theory, this approach gives fishers the security of knowing how much fish they can harvest in a given year, provides an incentive to operate efficiently, provides a mechanism for ITQs to flow

### 3.7 Malaysia: Experience in Effluent Control in the Palm Industry

|   | 1978     | 1979        | 1980        | 1981        | 1982        | 1984        | 1989        |
|---|----------|-------------|-------------|-------------|-------------|-------------|-------------|
| Biological oxygen demand standards (mg/l)                           | 5,000    | 2,000       | 1,000       | 500         | 250         | 100         | 100         |
| No. of mills  | 131      | 140         | 147         | 157         | 167         | 186         | 254         |
| Crude palm oil production (1,000 tons)                              | 1,786    | 2,188       | 2,573       | 2,822       | 3,511       | 3,715       | 6,057       |
| Biological oxygen demand generated (tons/Day)                       | 563      | 690         | 850         | 1,000       | 1,100       | 1,640       | 1,693       |
| Biological oxygen demand discharged (tons/Day)                      | 563      | 222         | 130         | 58          | 35          | 4           | 5           |
| <b>Percent reduction in biological oxygen demand load generated</b> | <b>0</b> | <b>67.8</b> | <b>84.7</b> | <b>94.2</b> | <b>96.8</b> | <b>99.8</b> | <b>99.7</b> |

Source: World Bank 1997

from the least to the most efficient fishers, and gives fishers a stake in conserving the resource and complying with the regulations.

Transferable quota systems such as this require considerable technical financial resources. System managers have to be able to make sound estimates of the sustainable catch and carefully monitor the catch to make sure that fishers respect the quotas. Equity may prove to be a problem with this system as well, since in time large operators with more financial resources may buy up all the quotas and squeeze out smaller operators.

Similar approaches are being used to optimize the number of visitors to national parks in Africa (through tradable visitor permits), the number of hotels built in tourist development areas (through tradable development permits), and the use of irrigation water (through tradable water shares).

Israel has greatly improved the efficiency of irrigated agriculture through a system of annual allocations of water and water charges. Farmers are allocated a certain volume of water based on the area cultivated, crop mix, and water requirements. In July 1990, 80 percent of a farmer's allocated volume was charged at \$0.125 per cubic meter and

the remaining 20 percent at \$0.20 per cubic meter. Consumption above the limit was charged at \$0.26 per cubic meter. The system also included a 40 percent premium on the price of water used during peak months. The system has significantly improved irrigation efficiency. Between 1951 and 1985, the water application rate fell from 8,200 to 5,200 cubic meters per hectare. Irrigation water use grew by 200 percent during this period, but the area under irrigation increased by 380 percent.

## The Global Context

Many international environmental agreements are already in place and more are likely over the next few decades. In each case, participants in such agreements must consider how they will respond. Nations can look at a variety of international and domestic policies, including both conventional "command-and-control" mechanisms and market-based instruments. A further choice is whether to use domestic policy instruments to meet international targets or goals or international instruments that can be employed jointly by a group of nations.

**Ozone.** To date, the most striking success at the international level has been the international

agreement to phase out ozone-depleting substances, primarily chlorofluorocarbons (CFCs).

In the United States, the government response to ozone depletion included an array of legislation, new regulations, bans, new product reviews, and economic instruments. Perhaps the central element of the U.S. strategy was a federal tax on ozone-depleting chemicals. The tax is applied to manufacturers' or importers' sale or use of ozone-depleting chemicals, taxable imported products, and floor stocks. Initially set at \$1.37 per pound for 1990, it has been raised annually since then; in 1997, the tax was \$6.25 per pound. For each chemical covered, the tax is calculated by multiplying the number of pounds produced or imported, the base tax amount per pound, and an ozone-depleting factor that estimates the potential for depleting ozone relative to CFC-11.

Several provisions were included in response to international competitiveness concerns, including a tax on imported ozone-depleting chemicals and imported products manufactured with those chemicals and a tax rebate on exports. They protected the U.S. domestic market from predation by foreign producers without a comparable tax and put the U.S. export market on an equal footing with nations that had not adopted a tax.

**Climate change.** As challenging as the international effort on ozone has been, the effort to reduce greenhouse gases – carbon dioxide, methane, nitrous oxide, and a few other heat-trapping gases – presents even more formidable challenges. The principal challenge is that fossil-fuel combustion is a primary source of carbon dioxide emissions, yet fossil fuels are used for much of the world's power generation, and there are few easy or quick alternatives.

In Scandinavia, several nations have introduced taxes on CO<sub>2</sub>, primarily on oil, coal, natural gas, liquid petroleum gas (LPG), and gasoline. To protect the international competitiveness of energy-intensive domestic industries, most of these taxes

have included special rules and tax abatements.

In Sweden, CO<sub>2</sub> tax rates vary according to the average carbon content of different fuel types, but were initially applied equally to households, non-manufacturing industries, mines, manufacturing, and horticulture. In January 1993, the industry rate was reduced to one fourth of the basic rate. The only exceptions are for gasoline and liquid petroleum gas. These rates are high and generate considerable revenue, with most of the proceeds used to decrease taxes on labor and to support energy efficiency projects. In 1992, the tax raised about \$1.1 billion, with about 5 percent of the revenue earmarked for projects on energy efficiency, renewable energy sources, and environmental support for the Baltic region. The tax has succeeded in lowering emissions from combustion sources for energy production, though the contribution from the transportation sector is rising.

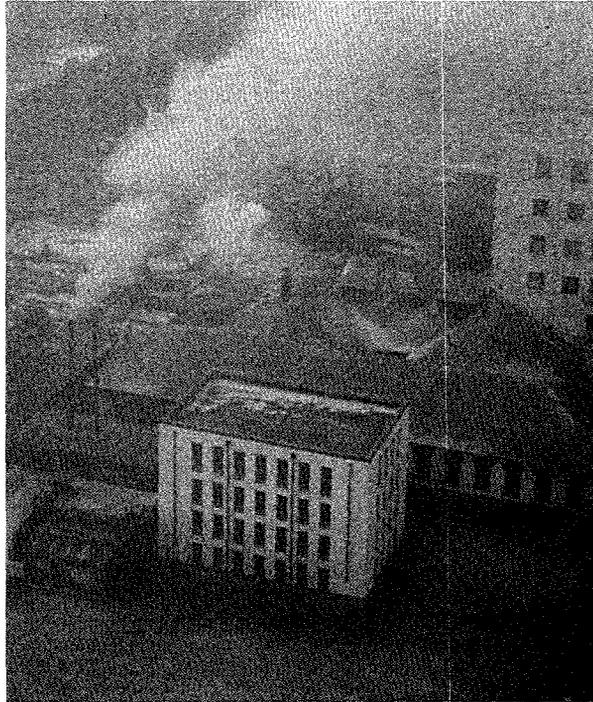
National CO<sub>2</sub> taxes are a promising initiative, but the global impact is not likely to be significant unless all nations agree to impose complementary taxes. In the largest industrial nations, portions of the business community will strongly oppose CO<sub>2</sub> taxes that could threaten their international competitiveness. Without global agreements and coherent multilateral action, CO<sub>2</sub> producers could in theory move to other nations that do not charge pollution taxes, so net global emissions might be unaffected. Furthermore, only global action will really address the problem; for example, Sweden's CO<sub>2</sub> emissions are only about 0.3 percent of the global total.

In the European Union, there have been a number of proposals to introduce universal carbon taxes. To date, progress has been slowed by the opposition of some countries, including the United Kingdom, and the concern that a carbon tax could put Europe at a competitive disadvantage unless the United States and Japan agree to a similar tax. Since neither the United States nor Japan appears politically ready for such a tax, there is for the moment little prospect for an OECD-wide carbon tax.

Several other variations on carbon tax proposals also are under consideration. One would target the emissions of international air and maritime transport, which to date have escaped taxation and are currently enjoying a competitive advantage over national transportation systems. Another proposal would charge a small fee on the trading of CO<sub>2</sub> emission certificates. This kind of fee is politically daunting, since it would require negotiation of an initial distribution of carbon emission entitlements and a protocol with emission targets. Compared to carbon taxes, such fees would generate relatively little revenue.

The Climate Convention also creates a significant new experiment in international offsets. Under the Convention's pilot phase for "Activities Implemented Jointly," developed countries can invest in greenhouse gas reduction projects in other countries. Emission credits – if allowed after the pilot phase – are likely to be shared between the investing and recipient country. The current convention defines joint implementation agreements as "efforts undertaken voluntarily and cooperatively between at least two parties in two or more countries that reduce, avoid, or sequester" greenhouse gas emissions. The parties could include the private sector, governments, non-governmental organizations, or academic institutions.

AIJ could be a critical first step toward the development of an international system of tradable permits for CO<sub>2</sub> emissions. Negotiating such a system will be difficult, since it must accommodate the historical responsibility of the developed nations, the right of developing nations to raise their standard of living, the need to share burdens and benefits equitably, and the need to keep total costs as low as possible. The potential economic benefits are enormous: one recent study estimated that the cost of meeting any given greenhouse gas reduction target could be cut by 50 to 70 percent under such a global trading program.



To date, however, the effort has proved controversial. Some developing nations and NGOs have criticized the program as a way for developed countries to avoid making real changes in technology or resource use. Practical experience implementing projects is limited, many technical and financial barriers are unresolved, and major developing nations such as Brazil, China, India, and Indonesia are not participating. Underlying these factors is a more fundamental issue: the willingness of developed nations to make binding commitments to reduce greenhouse gas emissions, and the willingness of developing nations to take part in such an agreement.

At the recent meeting of the parties in Kyoto in December 1997, it was agreed that joint implementation would be permitted between industrialized nations, but is subject to further elaboration of guidelines for verification and reporting.

Reduced subsidies for fossil fuels, which leads to higher fuel prices and reduced rates of growth in energy consumption and CO<sub>2</sub> emissions, are also having a substantial impact on carbon emissions. During the first half of the 1990s, OECD fossil fuel

## Jobs and the Environment

Early concerns that environmental protection would be harmful to economic growth and job creation have recently been muted by studies showing that the association between environmental safeguards and jobs is generally positive.

For example, local manufacturing and installation of photovoltaic cells is increasingly cost-competitive, especially in rural areas that have not been connected to electricity grids. India and Zimbabwe are among the nations where the PV industry is growing. Zimbabwe's program to install PV systems for household lighting now involves 55 companies that have generated 600 new jobs in installation, distribution, and manufacturing.

Practicing sustainable forestry can generate substantial numbers of jobs in areas such as reforestation and habitat restoration. British Columbia's sustainable forestry approach is currently responsible for about 12,000 new jobs in the forestry sector.

To control water hyacinths, a new program in Zimbabwe is using dried water hyacinths as a medium on which to grow mushrooms. Early

results have been impressive: one ton of dried hyacinths generated 1.1 tons of mushrooms. Several hundred jobs were generated by the pilot project alone.

In Ecuador, 1,800 new jobs were created involving the harvesting and marketing of tagua nuts, which are processed into hand-carved buttons for export.

In developed countries, recent studies suggest that eco-industries could generate a significant number of jobs over the next decade. Depending on levels of public investment and other factors, a recent OECD study estimated that 2 to 2.5 million new jobs could be created in the medium- to long-term in member states, including 500,000 jobs in the energy sector, 800,000 in construction, 800,000 in eco-industries, and 100,000 in agriculture and forestry.

In New York, a \$1.75 billion bond issue will generate roughly 56,000 construction jobs and 32,000 permanent jobs for environmental projects, including hazardous waste cleanup, habitat restoration, drinking water protection, solid waste landfill upgrading, recycling systems, and investment in low-emission buses and electric vehicles.



subsidies declined from about \$12.5 billion to about \$9.9 billion, or roughly 20 percent. In 14 developing countries, which account for about one fourth of global carbon emissions from industrial sources, subsidies declined even faster, dropping from \$60 billion to about \$33 billion, or fully 45 percent.

In China, petroleum subsidies fell from 55 percent in 1990 to 2 percent in 1995, while coal subsidies fell from 37 percent in 1984 to 29 percent in 1995. Since 1990, many other developing nations – including India, Mexico, South Africa, Saudi Arabia, and Brazil – also have cut fossil fuel subsidies significantly.

## Barriers to Implementation

As attractive as market-based instruments may be, the adoption of such initiatives in developing countries has nevertheless been relatively slow.

Many factors may contribute to the slow adoption of market-based instruments. A recent study of four nations in Latin America (Brazil, Mexico, Chile, and Argentina), identified the following factors as contributing generally to environmental policy failures: a widespread belief among policy makers that environmental protection initiatives would result in lower rates of economic development; inertia and lobbying against environmental initiatives that require internalization of social costs; lack of information on the real levels of environmental damages and risks; short-term planning practices and changing priorities from one administration to another; under budgeting of the sector, poor legal frameworks, lack of policy coordination and institutional overlaps; competition among states, and limited public support or participation. In addition, effective implementation of market-based instruments requires a strong environmental or sectoral agency.

In the four countries analyzed in Latin America, successful experiences with economic instruments invariably involved either strong sectoral agencies



setting more appropriate charges for services provided (for example, the water sectors in Chile, Mexico, Argentina, and Brazil) or establishing commissions to address specific environmental problems.

Other factors include:

- Until fairly recently, governments in many nations have strongly intervened in the economy, and to some extent this has undermined confidence in market mechanisms. Furthermore, instruments such as taxes, charges, and pricing policies require fairly stable economic conditions.
- Environmental agencies may believe they are technically unprepared to adopt market-based policies, which often depend on effective monitoring and enforcement. Furthermore, among environmental agencies there is a general belief that such policies will loosen agencies' control over polluters, and that the necessity to share administrative control with economic ministries could weaken them politically and increase the risk of policy failure.
- In both developed and developing countries, industry and other polluters have frequently opposed market-based instruments, believing that it is easier to avoid compliance with regulations and standards and that there will be less flexibility with fiscal and incentive mechanisms.



*People are only beginning to understand the economic importance of bats in controlling insect pests and as pollinators of many species of plants*

- Governments tend to keep prices below the private costs of production to protect the poor, and are often reluctant to revise such policies.
- Environmental agencies are often reluctant to view the provision of environmental protection as a service that can be charged for, and are similarly reluctant to adopt policies in which polluters must pay.

## The Bottom Line

Market-based policies are not a panacea, and should be coupled with other state responsibilities to reduce third-party effects.

Nevertheless, the experience with market-based instruments to date certainly suggests that they have evolved beyond theoretical and academic discussions and are now generally accepted as potentially useful additions to the arsenal of environmental policies. As general understanding of

environmental risks increases and public pressures build for more stringent environmental quality standards, these policies also present an opportunity to effectively shift the costs of pollution to polluters, create new incentives to prevent pollution, and lower the costs of environmental protection.

Market-based instruments should not be viewed as inexpensive shortcuts to the development of environmental protection policies in developing countries. Based on experience to date, they operate best in combination with an accepted and established body of direct government regulations. Countries still must wrestle with fundamental institutional and legal challenges, including improved management techniques, staff training, improved monitoring and enforcement capabilities, improved information on environmental quality, wider public participation, and sustained political determination.

Nevertheless, progress on these challenges is well underway in many countries where institutional and political capacities and the body of direct regulations are sufficiently in place to consider some creative new policies. In an era of shrinking government budgets, there is a general recognition that charges and tariffs that recover the costs of government investments make sense. Furthermore, indirect taxes that are relatively easy to administer and create incentives to reduce pollution are attractive, and – when considering the true costs of environmental pollution, such as the impacts of pollution on human health – are quite likely to provide net economic benefits.

Most national governments remain concerned about the international competitiveness implications of national policies. To some extent, international institutions can reduce some of these anxieties and help level the playing field by encouraging adoption of comparable market-based instruments around the world.

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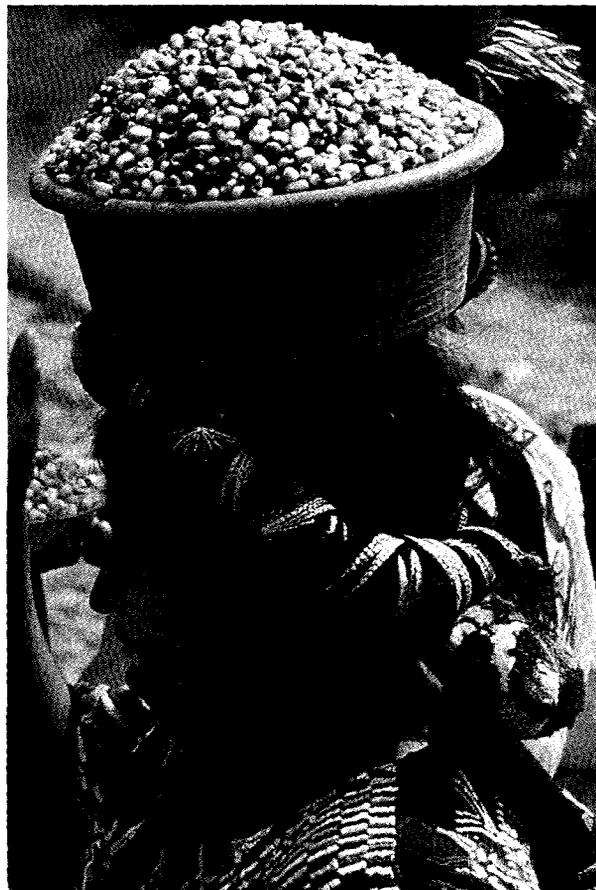
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# the biodiversity agenda

**“The library of life is on fire, and we must put it out.”**

*Gro Harlem Bruntland, former Prime Minister of Norway*

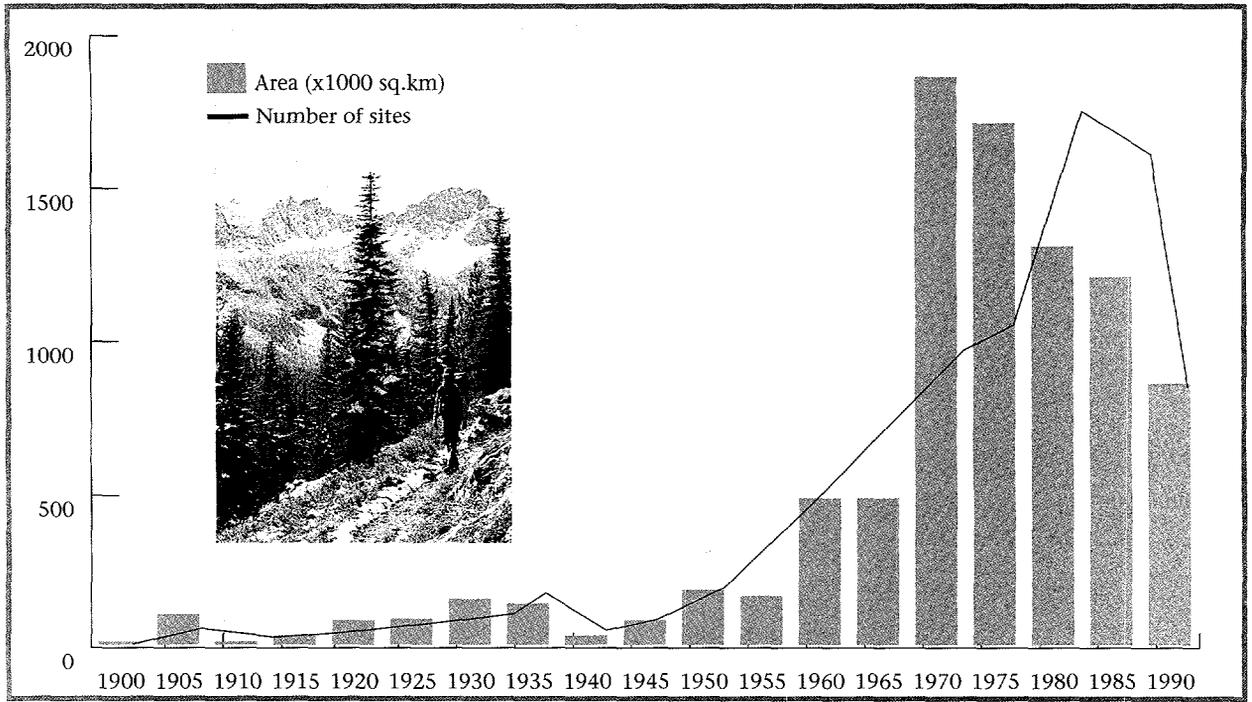
No environmental crisis will have a more lasting effect than the loss of biological diversity. Given a shift in attitudes, policies, and incentives, climate change could be reversed in a matter of centuries – international waters problems, particularly over-harvested stocks, in decades. Assuming cooperation under the Montreal Protocol continues, the ozone layer will begin healing itself well before the year 2100.

But biological diversity is a different matter entirely. Extinction is permanent. At the dawn of the 1980s, Harvard University biologist E.O. Wilson put the irreparable loss of genetic and species diversity above other problems as the “folly our descendants are least likely to forgive us.”

Records and remains of the auk and woolly mammoth continue to be studied and marveled at. Future generations will not even have the benefit of a museum in which to reflect upon much of the diversity lost today. But as this chapter demonstrates, they will still feel the effects.

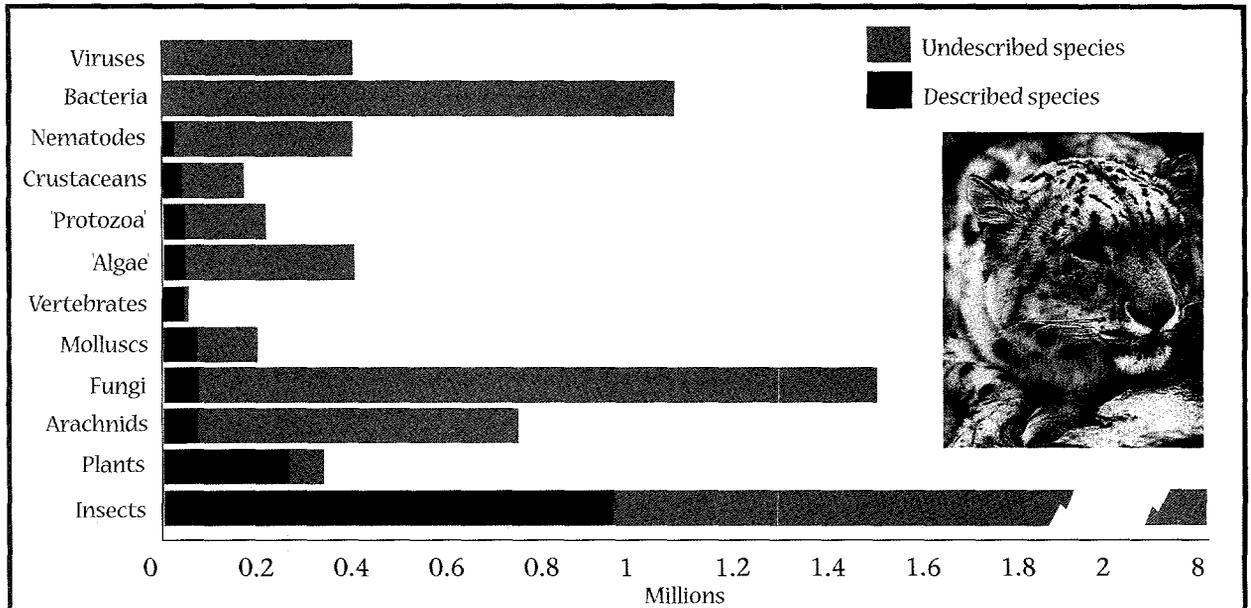
Continued, accelerated destruction of biodiversity threatens to impair the natural infrastructure supporting every human society and economic sys-

#### 4.1 Global Growth in Protected Areas, 1900-1990



Source: McNeely et al. 1994

#### 4.2 For most taxa, the vast majority of species continue to be unknown to science



Source: UNEP 1995

tem. Governments, NGOs, enterprises, and communities have mobilized to stem the loss:

- Designating over 10,000 national parks and protected areas larger than 1,000 hectares in size.
- Putting 150 million square kilometers, 8.2 percent of the world's land area, under protected status (Fig. 4.1).
- Adopting national and international laws to protect species in extreme danger of extinction, with the threat of trade sanctions backing them up.
- Forming community-based, national, and international environmental organizations to heighten awareness and promote solutions.
- Agreeing to the Convention on Biological Diversity (CBD) following the 1992 "Earth Summit" in Rio de Janeiro.

Even so, extinction continues at unprecedented rates. The root causes are well known. Land and water degradation, urban expansion, introduction of non-native species, climate change, air pollution, depletion of the ozone layer, overharvesting of commercial species, inadequate enforcement of environmental statutes, and distorted economic signals are all to blame.

Meanwhile, our knowledge of existing species remains woefully inadequate. Roughly 3,000 bacteria have been scientifically described in any meaningful way, yet a recent study of one gram of forest soil in Norway uncovered 5,000 different species. Barely 10 percent of the world's estimated eight million species of insects even have a scientific name (Fig. 4.2).

These examples may not reflect on past efforts as much as they highlight the magnitude of the challenge ahead. Assessing the significance and impact of this loss raises a number of critical issues: at what rate is biodiversity disappearing, why does it

## Extinction Momentum

Most species on earth trace their lineage back to an explosion of life in the Cambrian period some 500 million years ago. But this biological heritage is being rapidly eliminated.

The continuation of present trends is likely to result in the largest mass extinction in the past 60 million years and one of the six largest since life first evolved in the oceans some 3.5 billion years ago. Scientists have estimated that present rates of extinction are from one to ten thousand times higher than historical rates.

The majority of today's extinctions are believed to be concentrated among less obvious organisms, some of which have ranges restricted to a single rainforest tree. Such *endemics* tend to exist in fairly isolated geographic areas (islands, mountain tops, intertidal zones) or have evolved within a narrow ecological niche. These factors make endemics particularly susceptible to environmental change.

Even if all the variables that reduce biodiversity were halted today, extinction rates would remain high for at least a century. Past habitat loss and fragmentation have reduced many populations to such low levels that they are unlikely to endure beyond another few generations.

In the Everglades swamp of the United States, for example, the Florida panther has had its population reduced to less than 100 individuals from a combination of urban expansion, pollution, and hunting. Panthers are forced to in-breed, increasing the frequency of genetic disease and resulting in unhealthy offspring. It seems doubtful that the species will survive another century without intensive protective efforts. Most threatened species, less charismatic and largely unknown, will never have such an opportunity.

# A New Approach to Conserving Biodiversity

*Michel Batisse*

Compare a 19th century picture of a city like San Francisco, Nairobi or São Paulo with a contemporary view and the frightening urban sprawl that has taken place is only too evident. A similar contrast would appear if we were to look at landscape vistas of the Great Plains or of Kazakhstan over the same period. During this very short span of human history, the face of the Earth has seen changes far deeper than any since the last Ice Age.

Continued demographic growth and expanding per capita demands, along with massive technological impacts, are set to extend further this "artificialisation" of the land surface during the coming century. Three main land use zones in the world will result: one put under concrete and asphalt through urbanization and related activities, another devoted to intensive agriculture and forestry, and a third left aside in a state closer to natural conditions.

These latter areas will continue to shrink although they will remain by far the largest. It is here that most of the world's biodiversity is concentrated and has some chance of being conserved outside of zoos and botanical gardens. Unfortunately, such areas are themselves increasingly affected by human activities of various kinds, occurring in lines and patches in a most disorderly manner, thus fragmenting landscapes, destroying the structure of ecosystems, and upsetting their functioning. Wetlands, flood plains, hill slopes, and tropical forests are particularly affected.

The first thing to do for future conservation of biodiversity is to counter this fragmentation process through land-use planning, regulatory measures, and economic incentives, including compensation for extra-costs incurred (i.e. for roads or rail construction). Fragmented ecosystems, however, are preferable to destroyed ones and the conservation of biodiversity has to follow a very pragmatic approach. It must necessarily be based on sound scientific principles, but theory has to be tempered with practical realities on the ground. Given the present rate of ecosystem degradation, it must be

said that whatever can be saved should be saved now. The real issue is one of deciding where efforts should be concentrated and how and for whom these efforts should be made.

Biodiversity covers so many things, from genes to landscapes, that its conservation inevitably raises the question of priorities. In this respect, much attention is rightly paid to the so called "hot spots", mainly in tropical forests. This is where the largest number of species can be found, with coral reefs coming next. Biodiversity, however, has a tremendously wide range of values and occurrences and needs to be conserved on a great variety of sites and in widely differing situations, including in rural areas where humankind has long had an impact. The few plant and animal species of a desert are each as important from an ethical, economic, or scientific viewpoint as the great many species of a rain-forest, and no ecosystem on Earth is unworthy of conservation measures.

The traditional response has been to keep certain areas free from direct human impact through national parks or biological reserves. These are playing, and will continue to play, a most important role. They have, however, been established only where it was possible to do so, most often in areas of poor soil fertility or low population density, and thus do not cover other regions that are host to a large portion of the world's biodiversity. Most of these conventional protected areas have also been established without sufficient prior consent from neighboring communities which tend to become hostile when they want, through real need or common greed, to use additional land.

While such protected areas have to be improved, a new non-conventional approach is required, in which the imperatives of conservation can be reconciled with the legitimate claims of local populations for sustainable development. Such an approach is embodied in the concept of the "Biosphere Reserve", advocated by UNESCO, which is now widely recognized in many countries, and which has the advantage of being supported through a world network for scientific and economic research, information exchange, and training. Each Biosphere Reserve is made up of one or more core areas devoted

ed to conservation, surrounded by delineated buffer zones allowing certain activities, and an outer transition area for sustainable resource use.

The key to success for this flexible approach to biodiversity conservation lies in the partnership with local communities, which associates them with the design and management of the area and ensures they benefit directly from it. The economic benefits will vary greatly from site to site but should form a "critical mass" with such elements as non-timber forest products and ecotourism, and, above all, improved rural practices together with better education and health care.

Experience shows that this approach works in developed and developing countries alike at a relatively low investment cost. Such a scenario of ecosystems management could thus constitute a major component of regional planning and development in the coming century, which would have the added advantage of keeping more rural people away from shanty towns, empowering them with a key role in the conservation of landscapes and biodiversity, while allowing them to take their place in the market through specific products and services.

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matter, and, given biodiversity's value to human societies, how can we best conserve and sustainably use it, and equitably share the benefits?

## Biodiversity and Extinction

Diversity at the species level is the most common perception of biodiversity – a profusion of life filling every possible ecological niche from Arctic tundras to tropical rainforests and deep-sea thermal vents. But the scientific definition, drafted into the Convention on Biological Diversity, goes much further, incorporating everything from variability in the genetic code of individual organisms to the variety of landscapes and processes that make up ecosystems. The CBD's definition recognizes that diversity at each biological level – genes, species, and ecosystems – is equally crucial to the maintenance of Earth's life support systems.

A consensus on the state of the world's ecosystems emerged in the early 1990s, when UNEP commissioned – and GEF funded – the most authoritative and thorough biological review to date, the Global Biodiversity Assessment. Its findings suggest that Earth contains some 14 million different species, the majority living in tropical forests and marine systems. It will take decades, if not centuries, of further research to effectively provide anything more than the most rudimentary level of information regarding these species.

While some extinctions are precipitated by hunting and land degradation, others are more indirect, caused by the introduction of non-native plants and animals. These exotic species are able to take advantage of favorable environmental conditions and the lack of predators to overpower the new system they find themselves in. The consequences can be dramatic and costly. In the Black Sea, an American jellyfish introduced in the ballast water of a ship has decimated the region's anchovy fishery, contributing to some \$500 million in losses.

## Valuing Biodiversity

Biodiversity is integral to human welfare. It sustains the tangibles of society – a stable climate, medicines, the filtering of wastes by wetlands – as well as the intangibles of spiritual support, inspiration, and refuge. It should come as no surprise that the word “religion” derives from the Latin root meaning “connected” and “ecology” refers to the branch of science concerned with the connectedness of organisms and their environment.

Simply put, our biological capital is a basic underpinning of a sustainable and well-functioning society. More importantly, it is central to the viability of Earth’s life-support systems and the prevention of ecological collapse. It is increasingly clear that development based on continued degradation of the natural environment will ultimately fail.

Recent studies of the importance of natural systems have all highlighted the fact that, by and large, the natural services biodiversity provides for free are either prohibitively expensive to replicate or largely irreplaceable.

Just as the physical and human infrastructure of society – in the form of roads, ports, schools, and health care – is vulnerable to breakdown, so, too, is our global ecological infrastructure susceptible to decay. This is especially true for biodiversity because many of its services – nutrient cycling,

### Nature’s Pharmaceuticals

As the lucrative field of biotechnology expands, it continues to rely on compounds found in some of Earth’s oldest species. In early 1998, researchers in the United States announced the development of a new painkiller, derived from chemicals in the skin of an Ecuadorian frog, that is 200 times more effective than morphine at blocking pain, without the negative side effects, including addiction, that morphine induces.

pollination, flood and pest control – are less obvious and more difficult to measure. Perhaps nowhere is the value of diversity more closely linked to human welfare than in agriculture, where decreasing diversity stands as a major impediment to sustainability and security in the 21st century.

## Biodiversity & Agricultural Sustainability

Biodiversity is the heart of sustainable agricultural systems. Disparate cultures have created an impressive storehouse of agricultural knowledge by the development of landraces – genetically distinct varieties of crops – and complex techniques to select, store, and propagate valued species. The Tzeltal Mayans of Mexico, for example, can recognize more than 1,200 species of plants they use to address agricultural, medicinal, and spiritual needs. In the soil, a wide range of organisms from fungi to beetles provides the nutrient cycling and fertility crops require, while flying insects, bats and other species perform essential pollination services and help protect crops from increases in the pest population.

The past century has seen an erosion of the genetic resources needed to sustain agricultural production, leaving the world’s food supply more homogenous and vulnerable to pests and disease. Of the world’s major food crops, just three – rice, wheat, and maize – account for 60 percent of the world’s caloric intake. Moreover, the tremendous gains in yield since the Green Revolution have come at the cost of greater dependence on expensive fertilizers and pesticides, reduced diversity, and reliance on a narrower gene pool.

Diverse food crops serve as both a buffer from environmental change as well as a genetic bank for future crops. Large-scale monocrop plantations are often grown from a single parent stock, leaving the entire crop at risk to rapid attack by disease, pests, and inclement weather. While the Irish potato famine is, perhaps, the most well-known example

of the dangers of genetic uniformity in agriculture, recent examples abound.

In the 1970s, a virus attacked large swaths of genetically uniform rice crops in southeast Asia, threatening food security in this highly populated region. Several thousand varieties of wild rice were screened for resistance to the disease and, fortunately, a savior was found in a single species of weed-like rice from India. Whether there will always be such a fortuitous remedy is doubtful, given current trends in land degradation and extinction.

Other debilitating viruses, pests, and fungi have managed to decimate large plantations of coffee, rice, wheat, maize, and citrus in the past century with tremendous costs in terms of human lives and financial resources. Moreover, the stage has been set for more catastrophic events: according to a recent World Resources Institute report, nearly all the coffee trees in South America are descendants of a single tree in Holland, brought to Europe from Africa. Across Asia, genetically similar strands of rice continue to cover tens of millions of hectares.

## Natural Products & Sustainable Use

The vast majority of the world's people continue to depend on traditional medicine as the primary form of health care – health care that is directly dependent on diversity and traditional knowledge. The Zandu Pharmaceutical Company in India, for example, has built a successful business in traditional medicine based on 3,000 year-old Sanskrit writings. Picking through the forests of West Africa, South America, and Asia, traditional healers tap their environment's natural bounty to provide remedies for a number of common afflictions. Even in the wealthier nations, medicines from natural products are worth more than \$40 billion/year and, in the United



States, a fourth of all prescription medicines are based on active compounds found in plants.

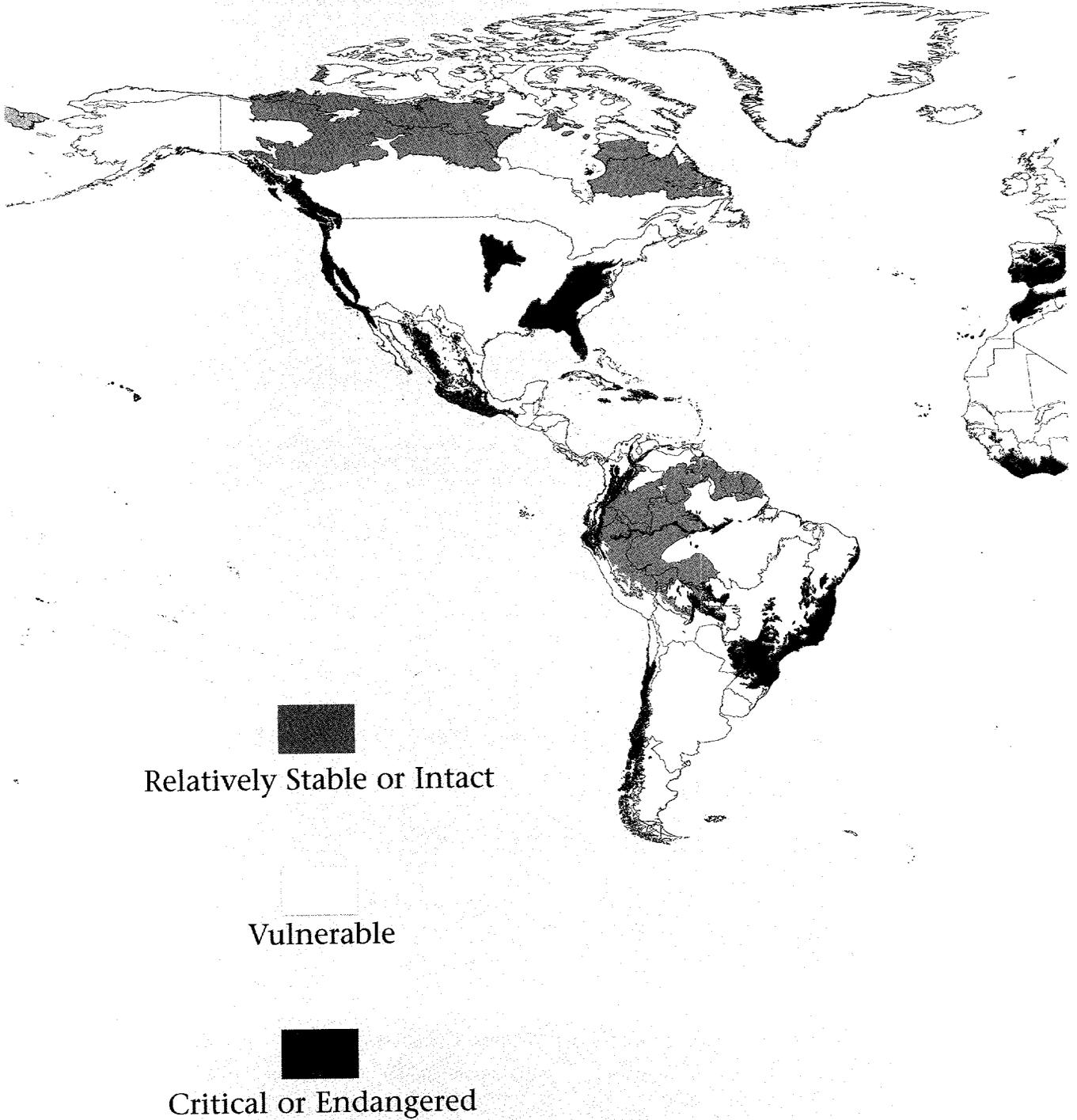
Diverse ecosystems are also the world's most valuable source of natural products and services at both the global and community level. They often provide significantly higher financial returns over the long-term than short-term schemes like logging or aquaculture. Sustainable use of non-timber forest products in one Peruvian rainforest, for instance, was estimated to be worth as much as \$6,000 per hectare per year, six times the value of clearcutting and more than twelve times the value of selective logging. In Indonesia, the flood barrier services alone of mangrove forests have an estimated replacement value of more than \$300,000 per kilometer.

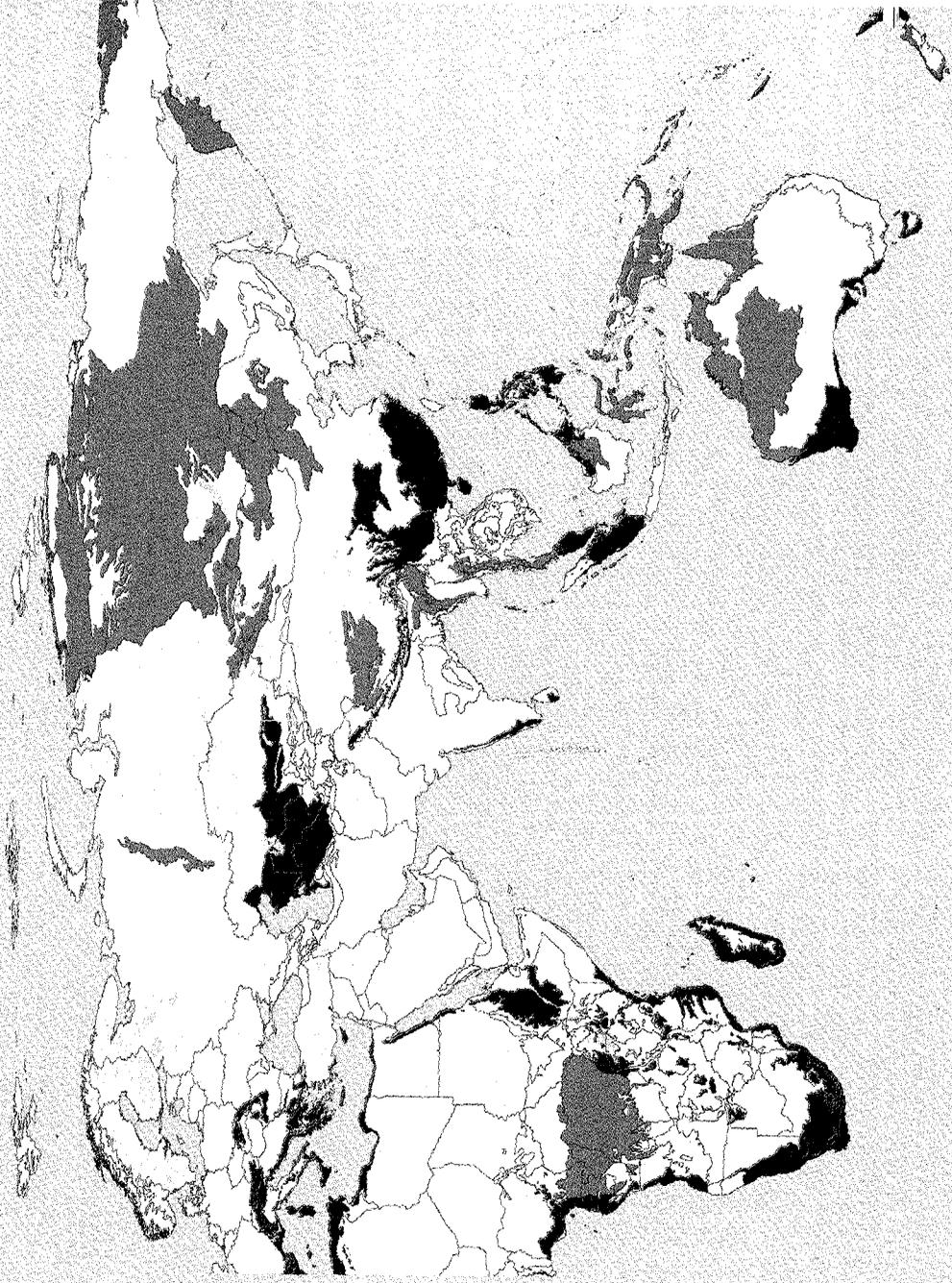
*Cancer cure: the rosy periwinkle*



Replacing ecosystem services with technological substitutes, however, is seldom cost-effective. In the Hadejia-Jama'are flood-

# Threatened Terrestrial Ecoregions





*The World Wildlife Fund has identified 200 priority ecoregions which encompass globally outstanding biodiversity features and are representative of each major habitat type within their biogeographical zones. This map highlights the status of each of these globally important ecoregions. One quarter of the identified regions are relatively intact; nearly half are critical or endangered.*

*Source: Olson and Dinerstein 1997*

# Keeping our Biodiversity Alive

*Edward S. Ayensu*

Keeping the world's biodiversity alive is the business of everyone who resides on this planet. For far too long, the state of our environment has been a contentious issue. The result is that we are losing sight of the need for all of us to work in concert to protect this earth. I believe that we possess the collective knowledge to ensure the continuity of our stewardship and the protection and repair of our planet. I also believe the time has come for both the business community and the environmentalists to engage in some serious soul-searching to use, conserve, and protect the world's biodiversity.

It is important for the business community to realize that the natural resources we are using today are the product of natural forces working during billions of years. Nature itself is a "business" that has been turning a profit aeon after aeon. So much of the present economic exploitation of tropical biodiversity is not only remarkably damaging, but also highly inefficient.

Avid environmentalists should appreciate the fact that a hard-line philosophy followed to its logical conclusion will only antagonize those in the business community who are concerned with the conservation of our planet and willing to do something to maintain its integrity for future generations. I further believe that the worst hard-core exploitations are by people in developing countries who thoughtlessly sell out their biospheric patrimony to foreigners from the affluent world.

A critical look at one economic sector – forestry – and its profound influence on the all-embracing livelihood of many people, suggests that millions of hectares of forests have been cleared for other uses during the past three or four decades. There have been comparatively few attempts to reforest these cleared areas. Such neglect has brought about major, often permanent, damage to millions of hectares of tropical watersheds. This degradation has frequently led to flooding or drought, loss of genetically valuable plant materials, famine, and the destruction of nature's balance.

More than half of Africa's deforestation is taking place in my own region of West Africa, where some of the most beautiful species-rich forests reside. If present trends continue, by the year 2020 there will be practically no marketable timber left and this sub-region, indeed, will have to import timber from other countries. It is ironic that while the tropical forests are being destroyed or converted, the forests of the developed nations are being stabilized and, in many cases, are actually increasing. It is essential that developing countries learn some pragmatic lessons from the forestry planning policies of the developed world about the productivity of forest resources and ensure domestic self-sufficiency, particularly in industrial round-wood supplies.

There are many in the affluent world who are oblivious to their dependence on tropical biodiversity, and the fact that loss of this natural resource will in some way affect their way of life. There are as many different kinds of plants and animals in the Republic of Panama as there are in all of Europe. There are nearly as many fish in the drainage basin of the Amazon River as there are in the whole of the Atlantic Ocean. Because of the wondrous diversity of species, we derive: numerous edible plants; industrial materials such as essential oils, gums, latexes, resins, tannins, other acids, phenols, alcohols, pesticides, and dyes; and medically useful alkaloids and other classes of chemical substances. These products form the basis of food items, cosmetics, sedatives, polishes, and even golf balls. Just remember your first cup of coffee or tea in the morning and think for a moment as to where the coffee beans or tea leaves originated.

It is in the best interest of the developed world to ensure that the current rate of deforestation in the tropics is seriously regulated and properly monitored. Furthermore, it is absolutely essential that the developed world work very closely with the developing countries to consider the kinds of environmental measures which, when properly handled, could lead to more sustained usage of the natural resources from these regions. Without such cooperation, the developing nations will end up taking short-term gains by over-exploitation of their natural resources.

Properly exploited, the tropical regions of the world will continue to represent a potentially inexhaustible source of natural resources for human use. The developing nations that are custodians of the biodiversity treasures will certainly benefit from the endowment and the beneficial ramifications in the economies of the developed world will go without saying.

Finally, I believe that short-sighted behavior which results in procrastination of sound environmental policies will eventually come to haunt us. The future of our earth is certainly in the hands of those whose activities impact the environment in more ways than one. However, we all – individually and collectively – create the economic realities with which we live, by which we live, and which will ultimately either bring us economic freedom or slavery. A display of the enormous ingenuity and resolve of the business community coupled with appropriate policies by both developing and developed country governments will certainly be financially rewarding and, at the same time, help keep our earth alive. These are the only dues that we have to pay for membership on this planet.

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plain of Nigeria, for instance, communities have developed a number of innovative means for living sustainably within their ecosystem's constraints. Taking advantage of the region's regular flood regime, they have prospered by using a wide variety of natural products and services – rich soil, fisheries, grazing land, and fresh groundwater. Nevertheless, proposals for modern irrigation systems continue to be advanced, despite economic studies which show that the present net benefits of such projects, \$29 per hectare, are far below the \$167 per hectare that results from existing uses.

The crucial consideration here is that these are values that continue indefinitely, from generation to generation, when used sustainably, while other uses often result in the permanent loss of such values and services. They are also values that policy makers seldom consider when examining the pros and cons of particular projects because constituencies that support them, where they exist, are often politically marginalized.

Many of biodiversity's most obvious benefits accrue at a level beyond the control of any nation-state. An analysis of the total economic value of Mexican forests, for example, arrived at a conservative estimate on the order of \$4 billion per annum, which stands a good chance of competing with returns from alternative uses such as logging. Much of this value, however, in the form of carbon sequestration, actually falls outside Mexico's borders, where no regional or global market is in place to effectively value the resource.

Without recognizing its value, the global community effectively free-rides on the carbon sequestration services of Mexican forests. While proposals such as enhanced ecotourism or full sustainable exploitation of non-timber forest products may help bridge the divide between actual and recognized values, mechanisms for regional and global support are required to fully incorporate and securitize these benefits.

### 4.3 Distribution of protected areas by biome type

| Biome type                                  | Total Global Area (km <sup>2</sup> ) | Number | Area Protected (ha) | Percent |
|---|--------------------------------------|--------|---------------------|---------|
| Tropical humid forests                      | 10,513,210                           | 506    | 53,833,388          | 5.1     |
| Subtropical/temperate rainforests/woodlands | 3,930,979                            | 899    | 36,629,731          | 9.3     |
| Temperate needle-leaf forests/woodlands     | 15,682,817                           | 429    | 48,722,746          | 3.1     |
| Tropical dry forests/woodlands              | 17,312,538                           | 799    | 81,755,123          | 4.7     |
| Temperate broad-leaf forests                | 11,216,660                           | 1507   | 35,823,999          | 3.2     |
| Evergreen sclerophyllous forests            | 3,757,144                            | 776    | 17,758,448          | 4.7     |
| Warm deserts/semi-deserts                   | 24,279,842                           | 300    | 98,400,670          | 4.1     |
| Cold winter deserts                         | 9,250,252                            | 136    | 36,472,009          | 3.9     |
| Tundra communities                          | 22,017,390                           | 78     | 164,504,267         | 7.5     |
| Tropical grasslands/savannahs               | 4,264,833                            | 59     | 23,512,784          | 5.5     |
| Temperate grasslands                        | 8,967,591                            | 194    | 9,998,248           | 0.8     |
| Mixed mountain system                       | 10,633,145                           | 1277   | 85,249,420          | 8.0     |
| Mixed island system                         | 3,252,270                            | 530    | 32,276,920          | 9.9     |
| Lake systems                                | 517,694                              | 17     | 663,486             | 1.3     |

Source: IUCN 1994

Note: 1 km<sup>2</sup>=100 hectares

## Diversity & Conservation Priorities

Diversity per se says very little about the stability or health of a natural system. An arctic tundra, for example, may not be any less stable or healthy than an Asian rainforest, though its biological diversity, in terms of the number of species or populations, may be far lower. Scientific research must focus on understanding the role of diversity in different ecosystems and the impact that its loss will have on ecosystem services which we take for granted. The results of this work can provide a much needed guide for policy makers committed to conservation, but unsure of how to prioritize their resources.

To date, the global distribution of protected areas has largely ignored certain areas, such as temperate grasslands and lakes (Fig. 4.3). This has primarily been the result of differing priorities in conservation. In many cases, spectacular scenery, charismatic animals, cultural and historical significance, and recreational opportunities have dominated the selection criteria for protected areas, leaving many biologically diverse areas at risk of continued degradation.

Moreover, in terms of pure biodiversity protection, efforts to date have often concentrated on salvaging remaining ecosystems and on areas where species diversity has reached its pinnacle. In a 1993 study of one such "hot-spot," Brazil's Atlantic forest region, scientists discovered some 456 tree species within a single hectare; by comparison, only 700 tree species can be found in all of Canada and the United States combined. It is not clear, however, whether such a narrow focus on species-rich systems is justified if it comes at the cost of less protection in areas where natural services are a major underpinning of development and where the web of life is more tenuous, and less prolific.

Drylands, for example, cover one third of the earth's terrestrial surface, are home to one billion people, and house species which are incredibly resilient and well adapted to extreme environmental conditions. Yet these same areas have traditionally been neglected when conservation priorities are established.

Land degradation in developing countries is often marked by mass poverty. Improved planning, extension services, and training and involvement of local communities, land use practices and man-

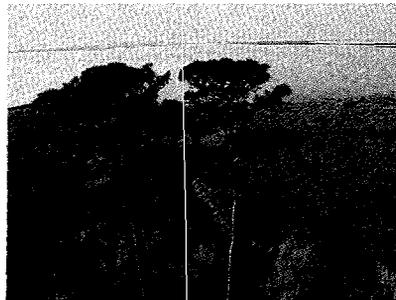
agement systems can increase vegetative cover, conserve biodiversity, and raise land productivity. Properly managed, wildlife can provide a source of livelihood to rural communities. Reforestation, afforestation, and forest ecosystems management can help prevent and control land degradation and ensure sustainable gains in biodiversity conservation.

Fortunately, in both marine and terrestrial habitats, restricted agendas are expanding to include the growing concern for the benefits and services biodiversity provides as well as the structural requirements it needs to survive intact. Clearly, moving beyond protected areas to incorporate ecosystem or regional management of biological resources, in conjunction with development programs, is a necessary precondition to establishing long-term sustainability in conservation.

In the debate over conservation strategies and governmental priorities, the very structure of the natural world is at stake. As biodiversity losses mount, ecological systems will begin to fail, and the human systems that depend on them will not be far behind. Governments, businesses, and organizations committed to enhancing the stock of biodiversity and ensuring the sustainable development of human societies must critically assess their efforts with regard to both components and consider a broader approach to conservation.

Without knowing which organisms or systems are irreplaceable for stable ecosystem functioning, a precautionary approach to conservation requires that nations proceed prudently when making decisions that could have potentially severe and unexpected environmental impacts.

Until there is greater certainty, however, there are a number of options available for policy makers and citizens to ensure that today's precautionary approach does not impede sustainable economic and human development. These alternatives,



#### 4.4 Human Domination of Earth's Natural Systems

|  | Percent |
|--|---------|
| Global land surface transformation                                       | 45      |
| CO <sub>2</sub> Concentrations due to human-caused factors               | 21      |
| Accessible fresh water used  | 52      |
| Terrestrial nitrogen fixation caused by humans                           | 56      |
| Introduced plant species (in Canada)                                     | 20      |
| Bird species that have become extinct as a consequence of human activity | 63      |

Source: Vitousek et al. 1997

when effectively implemented, will allow future generations as much opportunity as possible to efficiently use the benefits of biodiversity, economic and otherwise.

### Achieving Sustainable Conservation

No square meter of the planet has escaped the influence of humanity. Even in deep-sea habitats, fish that never make it near a dinner plate have been found containing 600 times more of the pesticide DDT than surface-dwelling species. Similar concentrations have been found for other persistent organic pollutants, which many scientists believe disrupt proper human endocrine and immune system functioning. These long-lasting compounds have even made their way to Arctic ecosystems, far from the agricultural fields where they were applied.

As anyone who has witnessed the garbage piles in the Himalayas or the floating algal blooms meandering along the South American coast can attest, the human fingerprint is now omnipresent (Fig.4.4). This recognition has given added impetus to global

# INBio & the Valuation of Tropical Biodiversity

Rodrigo Gámez

I was asked to summarize the role of the National Biodiversity Institute (INBio) in Costa Rica's quest for a development model that views the conservation of its biological diversity as a means to contribute to the welfare of its population. INBio's efforts are now part of the emerging initiative and paradigm of "sustainable human development", which is expected to guide the country into the next century.

In the particular case of Costa Rica, the dramatic effects of past deforestation raised the concerns of different sectors of society. It became clear to us that biodiversity has to be conserved for ethical, aesthetic, spiritual, economic, and other practical reasons. Inaction would obviously result in a severely degraded environment, and provide a serious threat to the quality of life of present and future generations.

In response to this threat, a national biodiversity conservation strategy has emerged, based on the premise that the best way to conserve wild biodiversity is to turn it into an instrument to further sustainable human development. As demonstrated in the course of history, biodiversity has contributed in numerous ways to our intellectual, spiritual, and economic development. It now has the potential to contribute in many other innovative ways, particularly with the availability of modern scientific and technological tools.

In order to develop biodiversity's potential, it is necessary to follow three fundamental steps: save representative samples of this biodiversity, know precisely what this biodiversity is and where it is, and find ways to use it in a sustainable manner.

Costa Rica's efforts to fulfill the first goal have focused on consolidating a network of wildlands within the National System of Conservation Areas, or SINAC. This system represents a first step towards a bioregional approach to natural resource management.

In order to increase biodiversity knowledge and promote its sustainable use, Costa Rica created INBio in 1989 as a non-governmental, non-profit, public interest, scientific organization. INBio's activities, developed in close coordination with SINAC, include:

- A national biodiversity inventory carried out with the direct participation of residents of rural communities ("the parataxonomists"), national technicians and biologists, and international taxonomists. The inventory prepares wildlands for their sustainable use.
- Organizing, collating, and managing information gathered by the inventory, as well as other sources, for the specific purpose of putting the information in formats that are easily accessible to a variety of users.
- The assessment of the state of knowledge about Costa Rica's biodiversity, conservation areas, and wildlands, and the existing policies and legislation regarding its conservation and development.
- The systematic search for non-destructive, economic uses of biodiversity. Bioprospecting activities are carried out in partnership with commercial, scientific or academic organizations. They are based on clearly established collaborative research agreements, formulated under national policy and legal frameworks and congruent with the terms of the Convention for Biological Diversity. These agreements address issues such as terms of access to elements of biodiversity, technology transfer, capacity building, funding of local research, and equitable sharing of economic benefits.
- The promotion and utilization of biodiversity information for intellectual, spiritual, and cultural purposes. Typical users include wildlands managers; political decision-makers; scientists; ecotourists; students of all ages, and the general public, all part of the "bioliteracy" program. Bioliteracy seeks to incorporate into the individual's intellectual and cultural repertoire the basic concepts and understanding of the meaning of life and the diversity of life on Earth.

The above mentioned activities and initiatives address the issue of using biodiversity for intellectual, spiritual, cultural, and economic purposes. INBio firmly believes that a clear perception by society of how biodiversity contributes to human welfare will further its valuation, promoting changes in attitudes towards nature and the development of a new environmental ethic in our population. This will allow the conservation of biodiversity into perpetuity.

These efforts are all carried out in close coordination and collaboration with national and international, public, private and scientific-academic sectors, and civil society. The combined INBio-SINAC partnership constitutes a pilot project in its own right, aimed at implementing the sustainable biodiversity development paradigm at a country level.

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conservation efforts, but with the acknowledgment that humans must be considered a crucial part of the solution.

## The Policy Response

Though national protected area systems date back to at least the nineteenth century, major international agreements to conserve biodiversity did not exist until the 1970s. International conventions on wetlands, on trade in endangered species, and on migratory species all led the way and now, nearly 30 years later, some 41 regional and global treaties are working to conserve biodiversity.

These changes on the international front have been driven by a number of factors, but a widespread recognition in the scientific community of the scale of the problem, similar to the one that precipitated action on climate change, coupled with the increasingly important role of non-governmental organizations (NGOs) in harnessing public concern, were crucial.

Beginning with campaigns focusing on individual species like the African elephant and on larger issues like tropical deforestation, broad-based NGOs such as the World Wide Fund for Nature (WWF) and the World Conservation Union (IUCN) helped bring the plight of biodiversity to a global audience. In doing so, they complemented the efforts of Greenpeace and other NGOs during the Montreal Protocol negotiations (see "Lessons from the Ozone Hole") to force governments to consider the views of their motivated members and stakeholders. Their influence has also been furthered by an evolving consensus regarding the most effective means of preserving biodiversity.

Many nations, particularly in wealthier and less populous countries, have seen the ecological, cultural, and educational benefits of setting aside large tracts of land for national parks. These parks continue to play an important role in preserving diversity. However, there has been a greater recognition over the last decade that strict preservation

# Living Within Nature

Thomas E. Lovejoy

It is often useful to point out that no organism exists without affecting its environment. This means that the issue is not whether humans affect the environment but how much and in what ways.

Using biodiversity as a convenient bottom-line measure of how we are affecting the environment, it is clear that we are having serious and continuing negative effects. For example, in 1997 the vast fires in Indonesia and the huge ones in the Amazon (where there was a smoke cloud larger than Brazil) obviously involved some major biodiversity loss — even if much of it was of species never seen by science and whose existence will never be recorded.

Others in this publication refer to various ways in which biodiversity is being affected negatively or value that is being lost. I would merely draw attention to the enormous importance of the existing array of plants, animals, and microorganisms as a huge library about things which are possible biologically. This is essentially the fundamental library from which the life sciences are built. Societies tend to put enormous value on libraries, much more than the paper and printer's ink of which the books are physically made. A similar approach to the living library would accord it far greater value than currently.

In the end I think the single most useful approach is that of ecosystem management which, if done properly, captures not only the processes of an ecosystem but also conserves the biodiversity which is its struc-

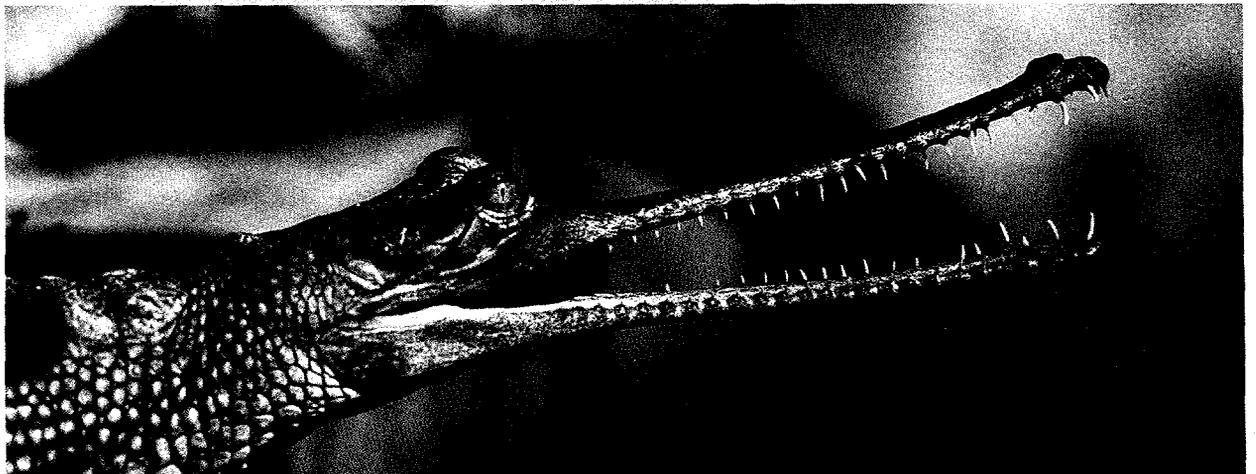
ture. The goal is to manage a relatively large and ecologically cohesive area so that ecosystem processes are maintained and the basic species list for the ecosystem is the same a century or millennium hence as it is today.

This requires taking into account all factors intrinsic to an ecosystem and all factors extrinsic, including climate change. It also involves working with local people to bring decisions about the environment to people where they live. When an individual property owner voluntarily cedes a bit of his or her right about management of that piece of the mosaic, they in fact gain much more from the ability to influence how surrounding pieces of the mosaic are managed.

Current experiments in the United States in South Florida, Southern California, and the Northwest are encouraging in the sense of progress made. It is not easy, and not everyone wins in the process but all indications are that land use, ecosystems, and biodiversity are in better condition than otherwise would be the case. If coupled with adaptive management in which land management plans are designed so that they can be scientifically evaluated, the process should be even more efficient.

What this entails in the end is a shift of perception — from nature being something for which bits of human dominated landscapes are set aside to think of our living (and pursuing our activities and aspirations) within nature. When that shift is achieved, biodiversity and the environment will once again be secured.

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may not be feasible in many developing countries; few areas are immune from the mounting pressures of poverty and population growth, and those that do exist are likely to be small and, hence, unsuited to securing the survival of biodiversity in the long run.

To better ensure that conservation activities can survive the test of time, and address the multiple concerns of human development, biodiversity protection, and the equitable sharing of resources, the national park plan has, in many locations, been broadened by innovative projects that attempt to capture, or securitize, the value of biodiversity. The notion of sustainable development is now being complemented by the idea of sustainable conservation.

There have been a number of landmarks in this evolving process. In the 1970s, UNESCO's Man and the Biosphere Program (MAB) sought to create a network of biosphere reserves, which incorporated a core protected area with buffer and transition zones in which local communities and other stakeholders could sustainably develop the area's resources. Other organizations, such as IUCN, UNEP, World Resources Institute, and WWF, have also had a prominent role in this process by leading the effort to produce the *World Conservation Strategy* and later the *Global Biodiversity Strategy*, which championed an integrated and holistic approach to biodiversity conservation and management.

One of the important outcomes has been the development of management tools such as "bio-regional planning", which identifies key core areas, surrounds them with transition zones, nests them within larger scale bioregions, and links them with biological corridors. Areas outside protected zones are designed to provide income and conservation incentives for local communities. This allows for a more equitable and scientifically appropriate balance between conservation and development. Without these efforts, ecosystem values may go unrecognized and the environment

will constantly be at risk from development priorities that are, in the long-run, unsustainable.

This recognition of the links between the environment and sustainable development was clearly reflected in the groundbreaking 1987 Brundtland Report, *Our Common Future*, and in the creation of the Convention on Biological Diversity (CBD), signed at the "Earth Summit" in Rio in 1992.

The CBD is the world's premier treaty addressing biodiversity loss, enshrining the concepts of national rights and responsibilities regarding natural resources. The three mutually reinforcing objectives of the Convention – conservation, sustainable use, and equitable sharing of benefits from biodiversity – are the new standard by which successful environmental practices will be judged.

The CBD provides a unique global policy forum, where national governments can promote international debate and action on many aspects of the biodiversity problem. The establishment of the CBD is the culmination of a process of integration of the social, economic, scientific, and technological aspects of the biodiversity challenge. Recent decisions of the CBD's Conference of the Parties (COP) have addressed a variety of issues in areas such as taxonomy, sustainable use, biosafety, invasive species, agricultural biodiversity, indigenous people, access to genetic resources, and incentive frameworks.

Several organizations support the implementation of COP guidance on these issues. The CBD's financial mechanism, operated on an interim basis by the Global Environment Facility, provides assistance to developing country Parties to the Convention through a number of different programs and projects. Following COP guidance, the GEF is helping countries meet the conservation, sustainable use, and benefit-sharing objectives of the Convention through a combination of conventional and innovative approaches.

In Costa Rica, a partnership between the GEF,

# Humanity's Ecological Footprint

*Edward O. Wilson*

The parlous condition of the world's fauna and flora can be stated succinctly as follows: In response, to population growth and economic development, humanity is quickly eliminating Earth's last natural environments and thereby forcing a large fraction of the world's species of animals and plants into extinction. The loss – economic, ecological, intellectual, and spiritual – will be felt for all generations to come.

Earth's population, after soaring from 1.6 billion in 1900 to nearly 6 billion at the present time, will reach about 8 billion in 2020, then perhaps stabilize at 8 to 10 billion later in the century. Eight billion people, most striving for higher levels of consumption, will be a heavy burden on the planet. The counterpressure that Earth is about to impose on this expansion of our numbers will not be a shortage of energy and minerals, as often supposed, but rather of food, water, and productive land. The problem is summarized by the "ecological footprint," which is the average amount of productive land needed to supply each person's consumption of food, wood products, fuel, and waste manage-

ment. The footprint of an average person in the developing world is about one acre. In the United States it is 12 acres. To bring the current world population up to the American level of consumption with present-day technology would require two more planet Earths.

That of course is not going to happen. But the rest of the world is launched on this impossible trajectory just the same. The result is the tightening bottleneck humanity faces, not to reach American levels of consumption, but just to survive with an acceptable standard of living. Today, technological improvements are raising productivity in most parts of the world, but at the price of drawing down faster and faster on the planet's natural resources. The yield from the combined oceanic fisheries, for example, has already peaked at 90 million tons a year, and several fisheries, including the once extremely rich northwestern Atlantic banks, have collapsed commercially. Of even greater import, per capita arable land is declining globally through a combination of soil erosion, water shortage, and population growth.

It should now be abundantly clear to leaders in science, government, and business that humanity will need every technological fix that genius can devise



in order to pass through the narrowest part of the bottleneck in the decades immediately ahead. More powerful technological innovations are required to salvage arable land, convert to carbon-free fuels, and miniaturize industrial components. There is an even more fundamental need – everything else will otherwise come to naught – to slow and then reverse global population growth. In order to live safely on planet Earth, humanity must use the full powers of its will and ingenuity to shrink its ecological footprint.

We hope – surely we must believe – that our species will emerge from the bottlenecks sometime in the 21st century in better condition than we entered. And we have another responsibility: Saving the Creation, by taking as much of the rest of life through with us as possible. The pressure on natural ecosystems – the forest, the wetlands, and other terrestrial and freshwater habitats, and now the open sea itself – is already very intense. Mass extinctions of species, especially in the tropics where most biological diversity exists are commonplace. They will grow more frequent as the pressure from population growth and poorly planned economic development increases. We could easily lose 20 percent of the world's species in the next several decades. The destruction of ecosystems and the species composing them erodes the foundation of the global environment, threatens immeasurable future wealth latent in wild species, and diminishes the pride of nations in their natural heritage. Not least, the destruction represents the breaking of a sacred moral obligation to our planetary home. Who are we to extinguish life on Earth?

In order to confine the damage, and with future generations in mind, each country should develop a natural resources policy that gives biodiversity the highest priority. Its fauna and flora should be carefully studied and mapped, and this priceless resource weighed and protected in every economic plan touching upon the natural ecosystems still left to us.

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INBio, the national government, and bilateral donors seeks to demonstrate that by promoting local capacity for collecting and systematically cataloguing information about species, the value of biological diversity and the marketability of biodiversity services improve.

In South Africa's Cape Peninsula, invasive alien species (especially *Acacia cyclops*) have the potential to spread and thereby eliminate the region's natural vegetation almost entirely. The GEF is complementing domestic resources to support eradication of alien species through a combination of biological, chemical, and mechanical methods.

In the area of biosafety, the GEF is funding a pilot enabling activities program in a broad range of countries in Asia, Africa, Latin America, and eastern Europe. The program, implemented by UNEP, will help countries develop national frameworks for addressing the risks associated with the use and release of modified organisms resulting from biotechnology which are likely to have adverse environmental and biodiversity impacts.

The 171 signatory countries to the CBD acknowledge the primacy of the precautionary approach in dealing with biodiversity, as well as the need to promote international cooperation and provide for additional financial resources to mitigate and prevent further erosion of the Earth's biological capital. Approaching the 21st century, even more partnerships based on the principles of the CBD are needed to integrate the parallel goals of sustainable development and increased investment in biological capital.

## Addressing the Challenge

Global economic integration, the revolution in communications technology, and a growing recognition of the planetary nature of the biodiversity problem offer unprecedented opportunities for establishing new partnerships for conservation and sustainable use. Promoting these partnerships requires making the most of the diverse repertoire of skills contained

## What About the Oceans?

Scientists have only been able to document the loss of one marine mammal and four marine mollusks in the last two hundred years. The vast majority of oceanic species, like their terrestrial cousins, don't have a scientific name.

Initially, many in the oceanographic community believed that marine species were safer, protected from human influences by the depth and breadth of their habitat. Researchers are quickly realizing, however, that many marine species may not be as resilient and wide-ranging as once thought.

In coral-rich areas, concern is growing that a network of protected areas, linked by surface water currents, is crucial to long-term protection of shallow marine resources. Otherwise the destruction of reefs in one area will have consequences for other locales, as planktonic larvae which drift on currents and help populate distant areas, decline in abundance.

within a wide cross-section of society.

While governments, NGOs, and businesses in both developed and developing countries have different comparative advantages, successfully addressing the challenge of sustainable conservation requires effective integration of these various efforts.

There is scope for novel partnerships in a range of areas, including improved ex-situ conservation, in the form of better funded and more taxonomically diverse seed banks in countries of origin; in-situ conservation, such as biosphere reserves, regional management of natural resources, and, in many cases, a devolution of control to local communities; and strengthened institutional capacity, in the form of better scientific knowledge and integrated sectoral planning.

## A Role For Government

Conservation and sustainable use will be the most effective if they are based on an understanding of the broad interlinkages between natural services and resource use decisions in a host of different economic sectors, including agriculture, forestry, transport, industrial, and urban development.

In many developed and newly industrialized countries, sectoral development is largely the result of market-based interactions between consumers and producers, with governments focusing on broad regulatory functions. In a large number of less developed countries, the national government still retains priority, particularly with regards to accessing international development funds.

In these countries, mainstreaming biodiversity management depends largely on integrating environmental concerns into the overall government structure. This is likely to be easier the more policy makers become aware of the income, employment and, more broadly, development benefits of appropriate environmental management.

For example, land use changes that result in the loss of vegetation cover and natural habitat establish the conditions for widespread soil erosion, which in turn severely impacts agricultural productivity. Significant proportions of public budgets in a number of developing countries are currently dedicated towards countering declining yields of export and staple crops, or, more directly, in supporting the dwindling incomes of farmers in low-productivity areas. A significant amount of these resources can be saved by reorienting agricultural and land use policies towards preventing, rather than mitigating, soil erosion and other forms of environmental degradation.

Agroforestry systems appear to represent, in many cases, a land-use option that is both ecologically and economically sound, with the potential for significant financial returns to small holders.

Environmentally, the benefits of agroforestry – high soil retention, a more diverse, species-rich landscape, and lower primary forest destruction – are superior to widespread monocrop plantations. However, sustaining agroforestry over time requires the organization of efficient extension, marketing, and credit schemes, such as cooperatives, that facilitate farmers' access to the necessary credit and technology inputs, and which overcome the barriers to profitability associated with a heavy reliance on middlemen. Many NGOs throughout the world are already working in this area, and central governments need to support these grassroots efforts.

A further area for government action is the reform of pricing policies. Throughout the world, governments at all levels need to address the unsustainable agricultural policies that have built up over the past century. For instance, one of the leading causes of habitat destruction and biodiversity loss, land clearance for agriculture, has often been driven by input and output subsidies. Globally, such environmentally destructive subsidies are estimated to be as high as \$700 billion per year.

In addition to removing harmful subsidies, pricing policies should also reflect the value of environmental services. Citizens in urban and industrial areas typically have access to water at prices that do not fully reflect the scarcity value of water. In particular, these charges usually do not recognize the contribution, in terms of guaranteeing water quality at the end of pipe, of vegetation maintenance in the upper watersheds. In addition to efficiency arguments, then, incorporating the value of environmental services in water charges may in many cases also be justified on equity grounds.

## Beyond Central Government

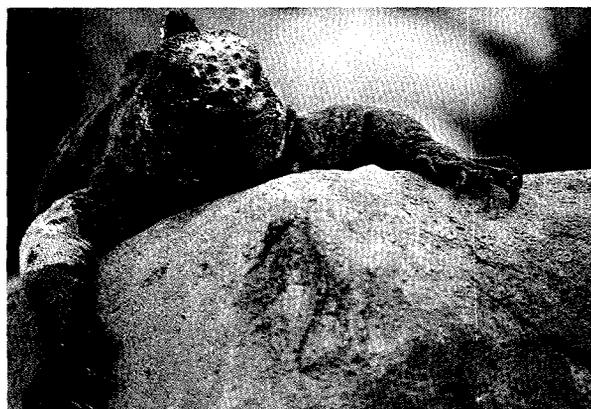
In many cases, moving towards sustainability requires a devolution of control over natural resources. In these situations, central governments can best support effective management of biodiversity not through direct engagement, but, rather,

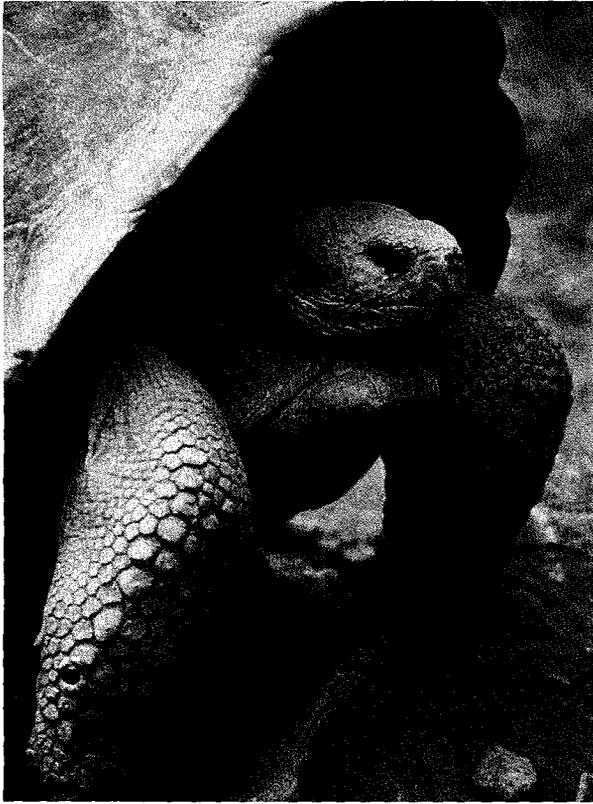
by creating incentive frameworks that lead or allow other stakeholders to undertake conservation or sustainable use activities.

Costa Rica, for instance, has designed a system of national reserves that, with local planning and support, operate within the parameters of sustainability. An exemplary application of this approach is given by the Area de Conservación Guanacaste (ACG), in the northwest portion of the country. Recognizing that the ACG provided economic benefits ranging from biological control and a clean watershed to the breakdown of organic waste and biodiversity information, the ACG staff negotiated with the area's primary agriculturist, a neighboring corporate orange grower, Del Oro, S.A., to receive substantial financial payments for those benefits.

In mid-1997, a 20 year contract was drawn up whereby Del Oro agreed to pay \$1/hectare per year for pest control services supplied by the ACG's insects, \$5/hectare of the ACG per year for water supply and watershed protection, and \$12 for the degradation of each truckload of waste orange peels produced by the farm. Other specific fees incorporated the full range of ecosystem services that the ACG provided.

These services were valued at \$480,000 over the 20 years, and the ACG allowed Del Oro to pay for these benefits in the form of 1,200 hectares of its forested lands adjacent to the ACG. This form of payment is not only easier for the company, but it also enables the ACG to obtain an important and





previously unincorporated parcel of forest on the interface between dry and rain forests. It also permits the ACG to use its scarce cash budget for its conservation and educational programs, which might otherwise go unfunded.

This project is one of many that the ACG has developed to move itself from a costly public good to that of a sustainable, revenue-earning institution. Today, all of the operating costs for the ACG, 2 percent of Costa Rica's land area, are met by a combination of its endowment earnings and cash and barter payments for services. This entrepreneurial approach to conservation is the latest effort to translate the benefits of environmental services into a recognized, tradeable commodity – thereby rendering conserved wildlands a productive sector of the local and national economy.

Fortunately, Costa Rica is not alone in recognizing that biodiversity protection must begin with grassroots support. Through a number of innovative programs, Curitiba, Brazil has become a model of

how to manage urban sprawl and pollution, while in Zimbabwe, the CAMPFIRE program has begun to spread to neighboring countries.

CAMPFIRE involves the decentralization of control over natural resources, and has helped provide incentives to local governing bodies to sustainably manage their resources. The program allows local communities to benefit by providing income from game hunts, eco-tourism, and enhancement of their environment. In some wards of Zimbabwe, households have received dividends as high as US\$650 per year, several times the average annual income. Though the project continues to receive international funding, expectations are that it will be wholly self-sufficient as the initial grants expire.

While these are all relatively recent programs, their efforts to sustainably use biological resources in the buffer zone of protected areas and elsewhere are models for providing incentives for conservation. However, even in the best of situations, there may be a number of barriers that local stakeholders must overcome to tap into the full range of benefits that biodiversity use may offer. These have to do with access to output and credit markets, availability of adequate human and institutional capacity, preservation of traditional knowledge on natural resource use, a reliable transportation infrastructure, and dissemination of contemporary technological innovations.

Fortunately, a number of local governments, NGOs, businesses, and academics have begun to focus on supporting stakeholders in overcoming the barriers that prevent realization of the economic potential of biodiversity use. Through these cooperative efforts, the global challenge of biodiversity loss may finally be met.

## Using the Global Marketplace

The discussion above hints at the circular nature of the biodiversity problem. Though a global concern, the loss of biodiversity will only be halted through concerted efforts on a variety of fronts

focused at the local level. Local actions, however, should take into account global implications and opportunities.

As the example of the Mexican forests highlights, biodiversity is not an asset whose valuation is solely limited to the nation-state. Translating the benefits of biodiversity at the international level into a meaningful construct requires the implementation of novel institutional frameworks and partnerships with the private sector as well as strong capacity building to ensure that nations are able to both take stock and protect their claim of the world's biodiversity. Even in the most remote community, sustainable conservation may be best achieved through cooperation with partners outside conventional system boundaries of the village, watershed, state, and region.

In the Oban hills of southeastern Nigeria and the Korup forest range of Cameroon, West African students are learning the fundamentals of natural resource management while collecting plants used in traditional medicine under a program supported by the Bioresources Development and Conservation Programme, the University of Yaounde (Cameroon), and Shaman Pharmaceuticals, among others. Their work includes studying cultivation systems for the vine *Ancistrocladus*, which contains a potentially valuable agent in the fight against HIV. Similar "benefits sharing" projects, which provide unprecedented links between global and local institutions and businesses, have been established in Chile, Argentina, Mexico, Suriname, and Peru.

One of the most powerful avenues for raising significant conservation funding comes from programs which tap into the growing market of environmentally conscious consumers. Through programs as diverse as eco-labeling and capacity building, a number of organizations and associations have found effective means of shifting to sustainable conservation.

The Forest Stewardship Council, for example, is

working to reduce the long-term negative environmental impacts of logging through their "Smart Wood" program, which works with NGOs throughout the Americas, Asia, Africa, and Europe. By creating a verifiable set of environmental standards, the Smart Wood Network is able to certify those forestry operations that practice sustainable timber management, protect biodiversity and watersheds, respect the rights of local communities, and address other environmental concerns. Certification by Smart Wood becomes a marketing advantage for those companies that use the more environmentally friendly wood in their products and local communities are guaranteed a steady, long-term flow of income.

In the Humla District of Nepal, a region that has long been isolated by the surrounding Himalayas, a group of organizations working through the Biodiversity Conservation Network (BCN) has managed to counter traditional threats to biodiversity and improve the livelihoods of people in the local communities. The communities have established a flourishing enterprise based on processing oils found in local plants which are used by perfume and cosmetic manufacturers. In the past, the plants themselves would have been the primary commodity, but with the establishment of two distillation mills, the processed oil from the plants provides higher returns to the community and creates a stronger incentive to conserve the local environment.

What these and other promising programs have in common is the recognition that, regardless of the global nature of the problem, effective solutions to biodiversity loss must involve the cooperation, energy, and knowledge of local communities to succeed. By empowering local communities, these types of initiatives are laying the groundwork for a more holistic integration of conservation and economic development. They are the first of a new generation of projects to acknowledge that successful long-term efforts at biodiversity protection must attain a critical balance between global needs and local aspirations.

# The Future of Biodiversity

Approaching the 21st century, the biodiversity challenge remains the same – preventing one of six great extinctions in earth’s history – but the efforts to address it evolve. If the remaining stock of biodiversity is to be viably protected, efforts must focus on policies that promote sustainable conservation, in order to ensure that all societies can continue to develop without destroying the very system their prosperity depends upon. The old argument that biodiversity doesn’t pay is being replaced by the realization that conservation represents the core of a sustainable world.

Among the more promising programs highlighted in this chapter are efforts by central governments to mainstream environmental concerns into their sectoral ministries while eliminating harmful subsidies; the broadening of the traditional national park concept to enhance conservation and provide incomes for local communities; projects by NGOs and other international institutions to help build capacity at the local level; and novel partnerships between the public and the private sector to securitize the benefits of biodiversity.

In the end, of course, these solutions all depend on the conscious recognition by individual citizens of the costs of continuing present patterns of extinction. What is at stake is nothing less than life on Earth. In Daniel Quinn’s book *Ishmael*, the protagonist, a silver-backed gorilla, offers some timely advice to his human colleague: “You must change people’s minds,” he says, “the world doesn’t need to belong to man – but it does need man to belong to it.”

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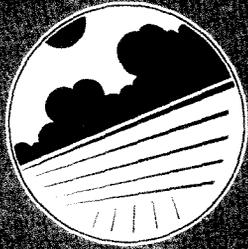
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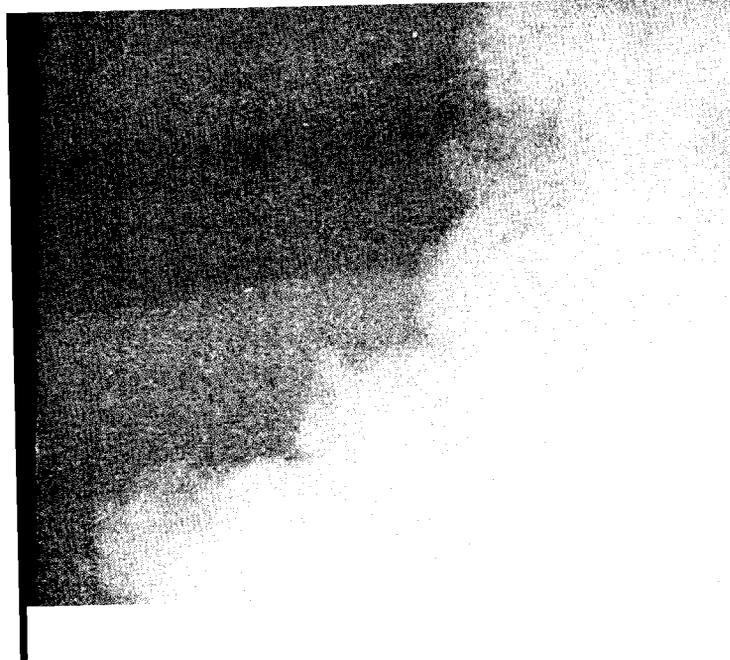
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# The Climate Challenge & Opportunity



A very old man once directed his gardener to plant a beautiful but slow growing tree. "Do you realize," said the gardener, "this tree won't bear fruit for decades?" "Why then," said the old man, "plant it right away, for there is no time to lose."



The first sight greeting many delegates attending the Kyoto climate change negotiations in December 1997 was an NGO-sponsored ice sculpture of penguins, melting in the mild winter sun. Inside the conference hall, delegates struggled to agree on a Protocol. Across town, in a smaller exhibition hall, new technologies, including hybrid vehicles that double fuel economy, were on display - evidence for economic growth consistent with dramatically lower emissions of greenhouse gases. (Fig. 5.1)

While the shape of the political solution to climate change is still hazy, technologies to address the problem appear closer than commonly realized. The fault lines in Kyoto were often along North-South lines, but the benefits of new technologies could be widely shared. Climate-friendly cars, power plants, and buildings can be better for development in all respects: lower cost and better for the local environment. Moving directly to state of the art technologies can mitigate if not avoid many of the traditional costs of growth. The success of these new technologies will require their introduction in the most rapidly growing developing nations, linking market opportunity with environmental necessity.

For the Global Environment Facility and other international bodies, the challenge now is to facilitate these new opportunities for partnerships - among the North and the South, national governments, and the private sector and NGOs.

## Confronting the Issue

*It is not the case that one end of the boat can sink... [climate change] is a developing problem in national security, and we have to deal with it.*

*Henry Kendall, Nobel Laureate, Physics*

In most parts of the world, the daily variation in temperature is more than 6 degrees F. Why, then, all the fuss about global warming that might not

## Evidence of Human Induced Climate Change?

Scientists know from atmospheric measurements that the concentration of carbon dioxide has increased from about 280 ppm prior to the industrial revolution to about 360 ppm today. They also agree that average surface temperatures have increased about 0.5C. But distinguishing human sources of climate change from natural variation remains a challenge.

One of the strongest indications is research on the pattern of changes in precipitation, which is consistent with the expectation of more extreme events. Other evidence consistent with expectations includes the fact that warming has been greater over land in mid to high latitudes and during the northern winter and spring; ice core data showing a close relationship between atmospheric CO<sub>2</sub> and temperatures for the past 160,000 years; the shrinkage of mountain glaciers; and the observed rise in sea levels.

exceed a few degrees? What does it mean to know that temperatures are now the warmest in the past 600 years, that two degrees would make the earth warmer than at any time in the past 10,000 years, or that over the next 100 years we may experience climatic conditions comparable to those before the ice ages began millions of years ago?

While climate change discussions typically emphasize the expected change in temperature, what matters most is how average temperature relates to local weather conditions. Enough is known to cause concern, but the most serious risks may lie in the unknown. The best understood consequences include a rise in sea level of about 50 cm by 2100 (primarily from the thermal expansion of the oceans and a smaller contribution from melting glaciers) and greater warming at the poles and in inland regions. Warming is likely to be greater at night. Paradoxically, the frequency and duration of both heavy rains and droughts are likely to increase.

The implications for coastal areas are obvious. Estimates are that sea levels have already risen about 18 cm in the past century, so the problem exists and requires a response whether or not attributable to climate change. As these areas have become increasingly popular places to live and visit, even modest sea level rise would result in bil-

### 5.1 Major Greenhouse Gases and their Characteristics

| Gas  | Atmospheric Concentration (ppm) | Annual Increase (percent) | Life Span (years) | Relative Greenhouse Efficiency (CO <sub>2</sub> =1) | Current Greenhouse Contributor (percent) | Principal Sources                           |
|--|---------------------------------|---------------------------|-------------------|---|--|---|
| Carbon Dioxide<br>(fossil fuels)<br>(Biological) | 355                             | .4                        | 50-200            | 1   | 55<br>(43)<br>(12)                       | Coal, Oil,<br>Natural Gas,<br>Deforestation |
| Chlorofluoro-carbons                             | .00085                          | 2.2                       | 50-102            | 3400-15,000   | 24                                       | Foams, Aerosols,<br>Refrigerants, Solvents  |
| Methane  | 1.714                           | .8                        | 12-17             | 11  | 15                                       | Wetlands, Rice, Fossil<br>Fuels, Livestock  |
| Nitrous Oxide                                    | .31                             | .25                       | 120               | 270   | 6  | Fossil Fuels,<br>Fertilizers, Deforestation |

Sources: Goldemberg 1996; Percival et al. 1996; WMO 1994

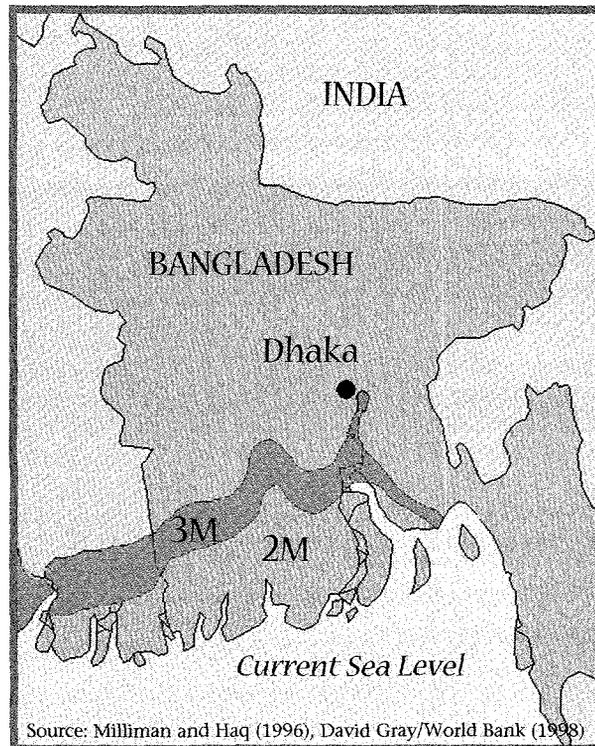
lions of dollars in property damages and the forced relocation of tens of millions of people. Sea level rise also extends the area subject to storm surges and exposes freshwater resources to saltwater intrusion. Due to development, natural adaptive processes are frequently no longer possible, so that ecologically critical wetlands could also disappear.

Because farming is so obviously climate dependent, the implications for agriculture have also been extensively examined. There may be beneficial effects in some regions due to longer growing seasons and the fertilization effects of increased CO<sub>2</sub>, primarily in higher latitudes. This assumes that soil moisture and water supplies remain adequate, and that losses from pests do not increase proportionately. In contrast, yields in some key commodities in developing countries are projected to decline by 50 percent or more in some regions – though these impacts could be limited by changes in crops, improved irrigation, and other management methods. Regardless of whether there is a positive or negligible impact on total production, the political implications of major shifts in agricultural location could be enormous.

The ability to adapt is critical to defining vulnerability to climate change. In general, scientists predict that many developing nations will be hurt the most because they are least able to afford the measures that might reduce their exposure. For example, while much of the Netherlands is only modestly above sea level, the population is concentrated and affluent and thus able to afford dikes and protective measures unavailable in Bangladesh or the Maldives. Many developing nations also tend to have much more of their economies involved in agriculture and other activities directly at risk from climate change, and some have large, growing populations in low-lying coastal plains already subject to flooding.

However, even the most wealthy nations are not immune from extreme climate events. For example, a heat wave that brought high nighttime temperatures to Chicago in 1995 caused more than

## Ganges Delta - Sea Level Rise Scenario



*Under a worst-case scenario, coastal nations like Bangladesh would be devastated by sea-level rise*

500 deaths. Flooding in the Netherlands the same year required the evacuation of more than 200,000 people. A single hurricane, Andrew, caused roughly \$40 billion in damages in 1993, the same year flooding on the Mississippi River caused damages of \$10 to \$20 billion. The insurance industry incurred \$14 billion in weather-related claims in the 1980s, but almost \$50 billion between 1990 and 1995.

The impacts of human-induced changes in drylands on the earth's atmosphere and on global energy balance have begun to be modeled with some success, given the many complex interactions involved. Frequent and prolonged droughts are known to increase local and regional atmospheric temperatures in drylands. As scientific research advances, the links between climate change and dryland degradation will become clearer.

Recent research shows that dryland soils may be playing a significant role in storing and fixing car-

# Inertia and Variability of the Climate System

*Bert Bolin*

The issue of a human-induced change of the global climate is a complex one. The risks for serious impacts on countries and people are real.

Nevertheless, these risks still may seem remote. Not seldom the attitude is one of "wait and see." Some argue: "After all, scientists have not conclusively shown that we so far have influenced the global climate. Why, then, worry?" Let me briefly outline a few basic reasons why I, as well as the IPCC, consider it important to address the issue seriously.

We are today able to associate the ongoing changes of the global climate with the modifications of the atmospheric composition that undoubtedly have occurred because of the increasing human activities on earth. We cannot prove this with absolute certainty, but there are similarities between the patterns of change as observed and those expected to occur as derived with the aid of climate models.

This association has been possible, in spite of the fact that human-induced changes still are partly hidden because of the inertia of the climate system. The human-induced patterns of change are only about now emerging out of the "noise" of the irregular, natural variations of weather and climate.

The inertia of the climate system is due to two characteristic features:

- Most of the greenhouse gases that we are emitting into the atmosphere stay there for a long time. It will take half a century or more before enhanced concentrations of carbon dioxide, nitrous oxide, and CFC-gases have declined by 50 percent, even if emissions suddenly stopped. Only methane has a rather short life-time in the atmosphere, 10-15 years. It accounts, however, at present for only about 20 percent of the total radiative forcing that is caused by the enhanced concentrations of greenhouse gases.
- Changes of the radiative forcing result in global warming only gradually. It simply takes time to warm the oceans. The observed warming during the 20th century shows up as an increase of the mean surface

temperature over the continents by about 0.8 degrees C, while the temperature has increased by only about half this amount over the oceans.

It is, however, not possible to stop immediately the use of fossil fuels as our main source of energy. This will take decades, until we have exploited available technical means to use energy efficiently. In addition, new inventions will further increase efficient energy use. Over the long term, new, carbon-free energy sources will have to replace a major part of our present use of fossil fuels.

We all know from personal experience that the climate varies from one year to the next. Observations tell us that decadal anomalies occur. This variability of climate differs considerably from one region to another. This natural variability is partly due to internal variations of weather that all are so familiar to us. In addition, some are presumably the result of variations of solar radiation, but we cannot yet tell whether one or the other cause is most plausible.

It then follows that it is still not possible to tell if a particular major regional anomaly of climate is due to the natural variability of climate or a result of human interference with the climate system. We recall the flooding in recent years of the Rhine in the Netherlands, the Oder on the border between Poland and Germany, and the Mississippi in the St. Louis area. Others may remember the droughts in southern Africa, California, Spain, and parts of Australia. Heat waves have hit some major cities. Hurricanes have caused excessive damage in the Caribbean and Pacific area. Anomalies of the El Niño phenomenon in the Pacific are now also on record. Some of these extreme events may have been partly influenced by our gradual changing of the global climate, but nobody can tell for sure.

In light of the basic inertia of the climate system and that it will take considerable time to change our own behaviour on Spaceship Earth, it seems appropriate to assess the risks for major future changes of climate as being most significant and that, accordingly, efforts to avoid such a development should not be unduly delayed.

*Bert Bolin is Chairman Emeritus of the Intergovernmental Panel on Climate Change.*



bon, and that controlling their loss could help mitigate global warming. Deforestation causes loss of carbon storage and increases in net carbon emissions. Some of the GEF's pilot-phase activities have explored the contribution that controlling deforestation can make to mitigating climate change. The Framework Convention on Climate Change recognizes the role of conservation and sustainable management of forests in carbon sequestration and in reducing carbon emissions. Protection of forests, afforestation, and reforestation also play very important roles in preventing and controlling land degradation.

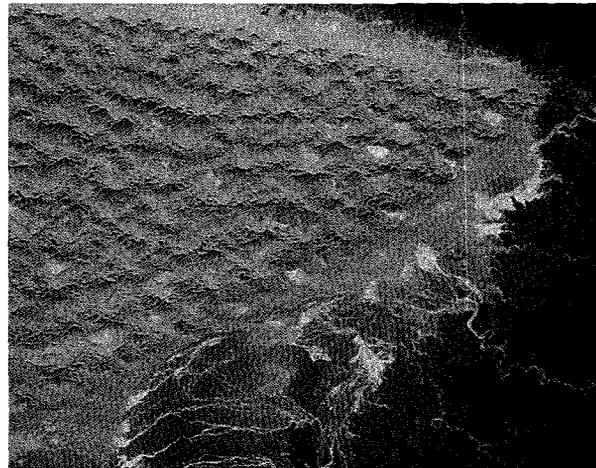
The most significant impacts of climate change on humanity may be more subtle and indirect. For example, changes from snow to rain and more rapid evaporation may result in significantly drier soils even as precipitation increases. Indirect human health effects may be serious if warmer temperatures expand the range of disease carrying insects. The combination of conditions more conducive to pest survival and the increased mobility of the world's population is already a major con-



cern for international public health experts.

Localized changes in climate can have much larger geopolitical ramifications. Droughts and floods have caused environmental refugees in many parts of the world, sometimes, as in central Africa, with serious consequences. Widespread starvation in North Korea, which reduced thousands of people to eating leaves and wild roots and affected more than five million people, was precipitated by extreme floods and led to greatly increased tensions in that region. Some nations subject to sea level rise have already begun to question who will accept their populations in the future.

Some of the most dramatic projections are on natural systems. Here the rate of change as well as the absolute magnitude of change is crucial. Ecosystems long taken for granted in particular regions are predicted to undergo enormous change. For example, sugar maples – long a fixture in the northeastern United States – and the Everglades system in Florida, both disappear in modeling forecasts. Wetlands and coral reefs may also undergo radical decline



# Positive Incentives for an Energy Transition

Paul Epstein

In the past two decades, 30 diseases new to medicine have emerged. In the past five years, the incidence of malaria has quadrupled, and cholera is more widespread than ever before.

The developed world has not experienced this magnitude of infectious disease resurgence since the 1830s, when Dickensian conditions in Northern cities precipitated epidemics of tuberculosis, smallpox and cholera. Societies responded with environmental and sanitary reform. Will we respond to the current upsurge of infectious disease, and address the underlying social and environmental conditions?

*Warming.* The resurgence of infectious disease is multi-factorial, but climate circumscribes the distribution of insect-borne diseases, while weather affects the timing and intensity of outbreaks. Insects causing malaria and dengue fever are now occurring at high elevations in Africa, Latin America, and Asia, while tropical summit glaciers are retreating, plants are shifting upward, and the level at which freezing occurs has shifted 150 meters since 1970.

*Extreme weather events.* Enhanced climate variability, instability, and extreme weather events are also bad for health. Floods foster fungal growth, support insect breeding, and spread chemicals and microorganisms in water supplies. Prolonged droughts encourage agricultural pests (like locusts, aphids, and virus-transmitting whiteflies), and they reduce protective predators – the owls, snakes, and coyotes that consume rodents transporting Lyme disease ticks, hemorrhagic viruses, and human plague.

*Costs of disease outbreaks.* The impacts of diseases affecting humans, crops, and livestock can ripple through economies and cascade through societies. The 1991 cholera epidemic in Latin America cost Peru over \$1 billion in seafood exports and lost tourist revenues. The 1994 Indian outbreak of plague (floods also precipitating upsurges of malaria and dengue fever) cost international airline and hotel chains from \$2 to \$5 billion. Cruise boats are

turning away from islands affected by dengue fever and harmful algal blooms.

*Getting beyond Kyoto.* Now that the community of nations has decided that climate is changing and that its cost may be severe, and has accepted what is causing it (burning fossil fuels and forests), we must address the solutions. North/South divisions seem insurmountable.

But are they? A substantial international fund could help drive the energy transition and benefit all. President Clinton has proposed a credit of \$6.3 billion over five years for an early action program for the US. But much more is needed internationally. Article 12 of the Kyoto Protocol specifically calls for a Clean Development Fund to jump-start renewable energy enterprises and energy-efficient technologies.

The Global Environment Facility (GEF) was established to transfer funds and technologies to promote sustainable development. Unfortunately, this consortium of UNDP, UNEP, and the World Bank was allotted only \$3 billion in the first few years.

An expanded fund could be used for some nations to develop appropriate technologies, and for others to buy them. This fund could be used to encourage development of new technologies and products in developed and developing nations, i.e., to provide “market-directing” mechanisms – such as tax credits, loan guarantees, and subsidies. Subsidies for purchasing nations would also pull the market and provide income for the producers.

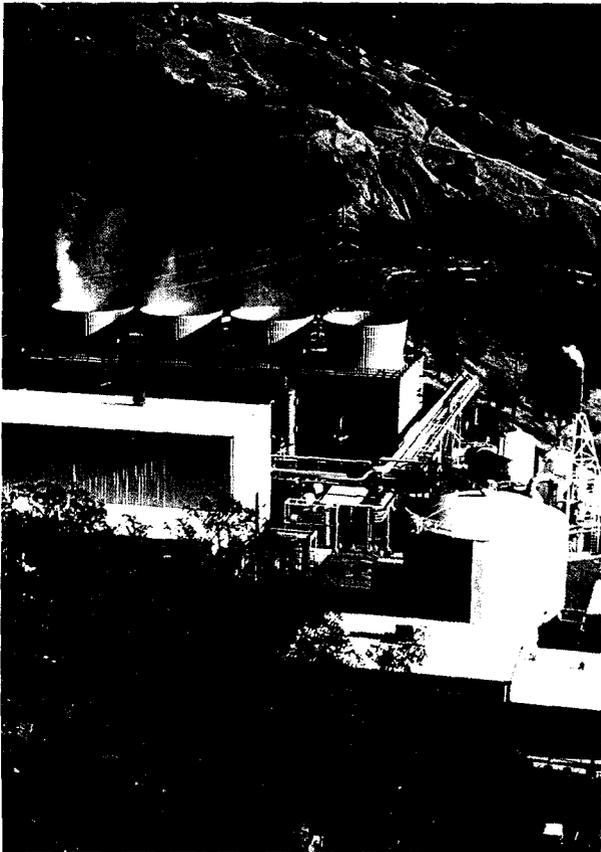
Recently, developed nations gathered over \$100 billion for financial bailouts in East Asia. Why not a comparable fund to meet a problem with possible dire consequences for all?

*A modest proposal.* Every day \$1.2 to \$1.5 trillion is exchanged on the currency markets. A minimal tax of 0.1% on daily transactions – one dime for each \$100 exchanged – could generate some \$300 billion annually. (The “Tobin Tax” of .01 percent was first proposed in 1972.) This would constitute a global insurance and protection policy.

Such a fund could set the stage for developing nations to sign on to the climate treaty and develop, but with a new energy profile. This level of commitment could also bring in industrial and political interests in developed nations. Such a magnitude of funds could also support United Nations and World Bank/IMF needs for financial stability. Concerns about sovereignty could be overcome with national bodies to administer the process.

No process of transformation can rely on penalties and punishments alone. Positive incentives are needed to push and pull this energy transition, especially given the built-in inertia and incentives for nations to continue to abuse the environment. Making substantive the international fund called for by the Kyoto Protocol can catalyze an economic transition with participation by all, the economic benefits of which may yet surprise us.

*Paul Epstein is Associate Director of the Center for Health and the Global Environment at Harvard University Medical School.*



*Geothermal plant in California*

## A Timeline of Climate Science

*Mid 1980s:* UNEP and the WMO successfully produce an international review of the science of stratospheric ozone depletion as the basis for governmental action to protect the ozone layer.

*1988:* Governments agree to support an international scientific evaluation of climate change, the Intergovernmental Panel on Climate Change (IPCC), supervised by the WMO and UNEP.

*1990:* First IPCC assessment of climate change published based on participation of several hundred experts from all over the world.

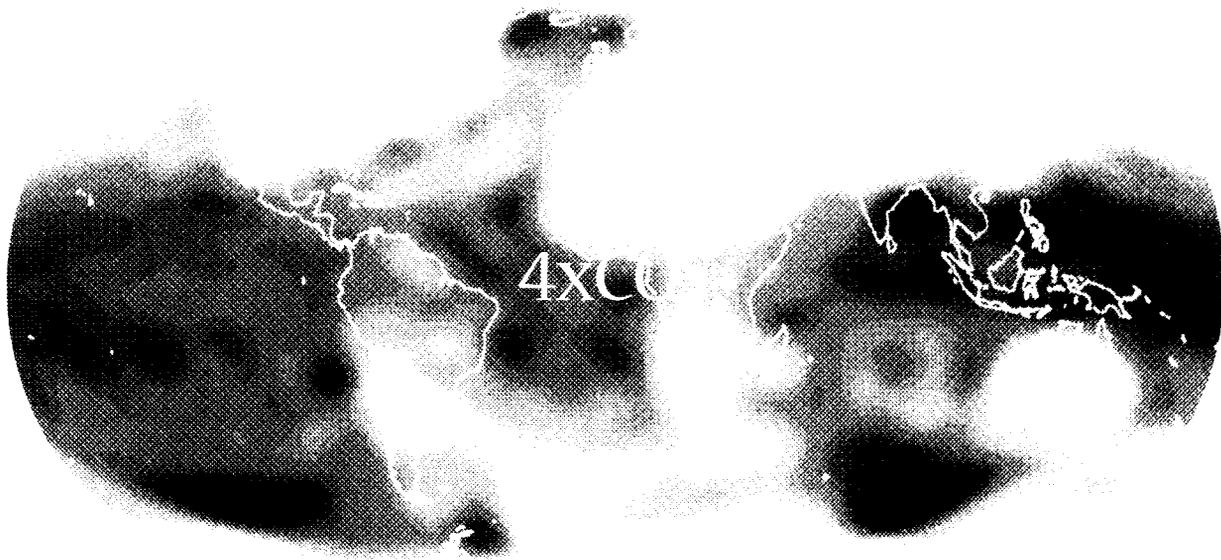
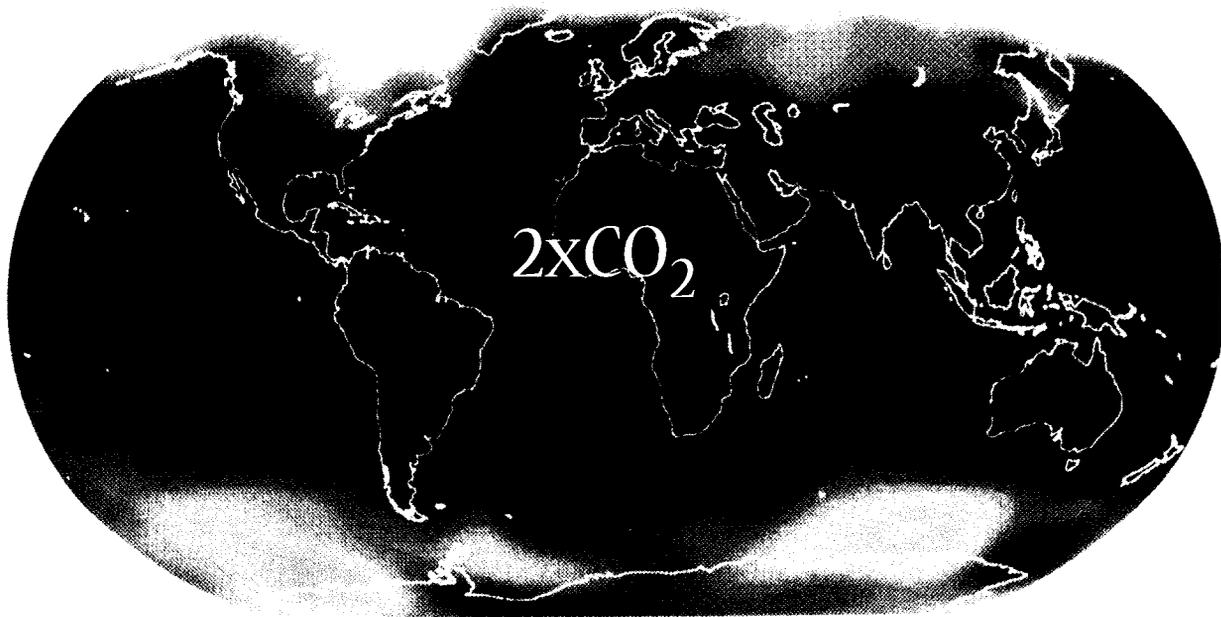
*1996:* Second IPCC assessment concludes that "the balance of evidence suggests that there is a discernible human influence on global climate."

due to climate change.

The result is yet another source of accelerated loss of species and an additional challenge to efforts to promote biological diversity. The more gradually climate changes, the easier it could be for species to adapt. As a result, ecologists have proposed that emission constraints be calculated so as to limit the rate of warming to no more than a tenth of a degree per decade.

The greatest risks may be those yet to be discovered. Just as the Antarctic ozone hole was an unanticipated surprise, scientists have hypothesized many troubling possibilities, including more frequent or severe hurricanes and a shift in ocean currents responsible for moderating the climate of northern Europe. As we learned in the context of ozone depletion, what we don't know can hurt us – the rate of ozone depletion proved to be much greater than what had been predicted. The most serious effects of climate change too may lie outside current calculation.

The evolution of a common international scientific understanding of such complex issues has been a critical step toward addressing the problem,



*Degrees Celsius (C)*



another common feature with ozone depletion.

## Forging Consensus for Action

Even the longest journey begins with a single step.

Formal international discussion of climate change began with the first World Climate Conference convened under United Nations auspices in 1979. The first official step toward a policy response came with the Framework Convention on Climate Change, signed by more than 150 governments in Rio de Janeiro in 1992, with the goal of stabilizing greenhouse gas concentrations in the atmosphere “at a level that would prevent dangerous anthropogenic interference with the climate system . . . within a time frame sufficient to allow ecosystems to adapt naturally.”

Developed countries agreed to the “aim” of returning their emissions of greenhouse gases in 2000 to the same level as in 1990. Developing countries agreed to prepare inventories of emissions and strategies to mitigate climate change with financial support from the industrialized countries.

Although a “framework,” the Convention also incorporated several key principles. First, a reference to the precautionary principle made clear a recognition that the character of the risks was such that action need be taken prior to resolving all scientific uncertainties. Second, the concept of “common but differentiated responsibilities” recognizes that while responsibility needs to be very widely shared for the Convention to be effective, considerations of equity require that national obligations be adjusted to reflect stages of development.

The wealthiest nations, listed in Annex 1 to the Convention, agreed to accept the need to demonstrate leadership in reducing their emissions, and to provide financial and technical assistance as a

*Without reductions in CO<sub>2</sub> emissions, atmospheric CO<sub>2</sub> could rise to four times preindustrial levels  
(Map source: Geophysical Fluid Dynamics Laboratory, Princeton University)*

result. The Global Environment Facility was named the interim financial mechanism to the Convention.

Another innovative principle is the need to allow flexibility for the purpose of achieving environmental goals in the most efficient manner. This goal is reflected in provision for “joint implementation,” the potential attainment of emission reductions by one Party through actions taken in another Party.

By the end of 1997, emissions had increased in all but a few of the Annex 1 nations and prospects for meeting the year 2000 target were poor. This failure emphasized the need for some further agreement to be concluded in Kyoto, Japan, the site of the third Conference of the Parties.

## The Road From Kyoto

*The Kyoto Protocol will become a 21st century koan, a Zen-like riddle or challenge to break through boundaries imposed by political, economic, technical, and cultural practices. . . .*

Earth Negotiations Bulletin, vol. 12, no. 76

At Kyoto, delegates from more than 160 nations concluded a two-year process to produce a protocol to the Climate Convention. Reflecting the magnitude of the issues at stake, there were more than 10,000 participants, including representatives from the business community, environmental NGOs, and the media. While there were major differences in the positions of industrialized nations, the greatest controversy focused on two issues: whether some form of emission trading would be permitted, and whether developing nations would assume new commitments.

Agreement came only after a dramatic all-night session as food ran out, the heat was turned off, and many delegates were seen slumped over in their seats in the final “negotiation by exhaustion.” Substantial progress was made on several key points but much was left for the November

## Reduce Subsidies & “Leapfrog” Old Technologies

*José Goldemberg*

Regardless of the severity, it is clear that developing countries are more vulnerable and will be the first to suffer from global warming. These countries are more dependent on agriculture and lack the resources and infrastructure to cope with severe floods, droughts, and sea-level rise.

It is enough to compare the effects of a flood in Mississippi to one in Bangladesh to realize that thousands of lives are lost in the latter, while in the former, material damage and minimal loss of life is incurred. Developed countries – now responsible for about three quarters of greenhouse gas emissions – can entertain ideas about adapting to higher global temperatures, but this is not the case with developing ones. Preventive action is the only kind that makes sense.

The overall solution is to set a “cap” on emissions. How realistic is this goal? Industrialized countries are grudgingly agreeing to stabilize their emissions at the 1990 level by the year 2010 and eventually at 5 to 8 percent below that level. In addition, developing countries are trying to moderate the increase in emissions by removing subsidies on fossil fuels.

The success, albeit limited, of such policy can be gauged by the fact that between 1990-91 and 1995-96, total fossil fuel subsidies in 14 developing countries – accounting for a fourth of global carbon emissions from industrial sources – declined 45 percent, from US\$60 billion to about US\$33 billion. During this same period, OECD subsidies declined by 20 percent from US\$12.5 billion to US\$9.9 billion. Reduced subsidies lead to higher fuel prices and reduced rates of growth in consumption and carbon emissions, through technological improvements and changes in lifestyles.

More “proactive” policies – and government expenditures – will be necessary to further reduce consumption of fossil fuels and the resulting emissions. Returning to 1990 CO<sub>2</sub> emissions levels in OECD nations will require a reduction of approximately 300 million tons of carbon per year through energy conservation and renewables. This is likely to cost at least US\$20 per ton of carbon avoided – which means expenditures of US\$6 billion per year.

Joint implementation (JI) could reduce these costs because in developing countries there are cheaper ways to reduce or offset carbon emission such as afforestation. However, JI has proceeded slowly, so far. The great driver for further reductions will be the creation of a market for “tradable permits” that will be a consequence of the adoption of mandatory caps on emissions. Active trading is expected between Annex I countries and undoubtedly many developing countries will adhere voluntarily to this



system to benefit from it.

Developing countries are not presently bound by any reductions in their emissions, which are growing at 4 to 5 percent per year, largely due to ongoing industrialization and improving standards of living. On a "per capita" basis, developing countries still consume far less energy and emit much less pollution than do wealthy nations (Figs. 5.2 and 5.3). It is therefore unfair and unrealistic to expect developing countries to accept the same limitation on emissions as industrialized nations; ultimately, however, developing countries will have to accept limitations if the risk of global warming is as severe as most scientists think.

What can be done at this time to steer their growth and development in directions that will make the best use of modern, cleaner technologies, "leapfrogging" costly and polluting solutions adopted decades ago? This will require a special type of technology transfer. For example, the enormous expansion of the automobile industry in developing countries runs counter to the long term interests of reducing global carbon emissions. It is essential that developing countries incorporate – early in the process of development – efficient and modern technologies that are now available. Developing countries are important theaters for innovation, especially in energy-intensive, basic material industries (such as steel, chemicals, and cement), which are growing rapidly.

An example of "technological leapfrogging" taking place in Brazil is a project that will demonstrate electricity generation from biomass. This project is supported by the Global Environment Facility.

A "double dividend" of "leapfrogging" to modern efficient technologies is the fact that most current expenditures on environmental protection (about US\$100 billion in the US alone) are used to mop up toxic sites, scrub coal power plants, etc. Leapfrogging minimizes the cost of environmental clean up – and that makes economic sense even in the absence of other benefits.

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## Key Outcomes of the Kyoto Protocol

- Industrialized nations agreed to reduce their aggregate emissions of a "basket" of six greenhouse gases by at least five percent below 1990 levels in the period 2008-2012. National commitments vary from an increase of 10 percent to a decrease of 8 percent relative to 1990, reflecting differing circumstances.
- Joint implementation, or the transfer of credits for emission reductions, is permitted between industrialized nations but is subject to further elaboration of guidelines for verification and reporting.
- A clean development mechanism will oversee emission reduction projects in developing nations. The result will be certified emission reductions, beginning as early as 2000, for use by industrialized nations to meet their reduction targets. A share of the proceeds will be dedicated to pay for adaptation expenses in nations particularly vulnerable to climate change. The rules and procedures for project certification, verification, and accounting are to be determined at the next meeting of the Parties (Article 12).
- The Protocol will enter into force 90 days after ratification by not less than 55 Parties to the Convention, including industrialized Parties that in total accounted for at least 55 percent of the total CO<sub>2</sub> emissions for 1990.



## 5.2 Highest Industrial Emissions of Carbon Dioxide, 1992

| Rank | Country            | Total CO <sub>2</sub> Emissions<br>(million metric tons) |
|------|--------------------|--|
| 1    | United States      | 4,881,349  |
| 2    | China              | 2,667,982  |
| 3    | Russian Federation | 2,103,132  |
| 4    | Japan              | 1,093,470  |
| 5    | Germany            | 878,136  |
| 6    | India              | 769,440  |
| 7    | Ukraine            | 611,342  |
| 8    | United Kingdom     | 566,246  |
| 9    | Canada             | 409,862  |
| 10   | Italy              | 407,701  |

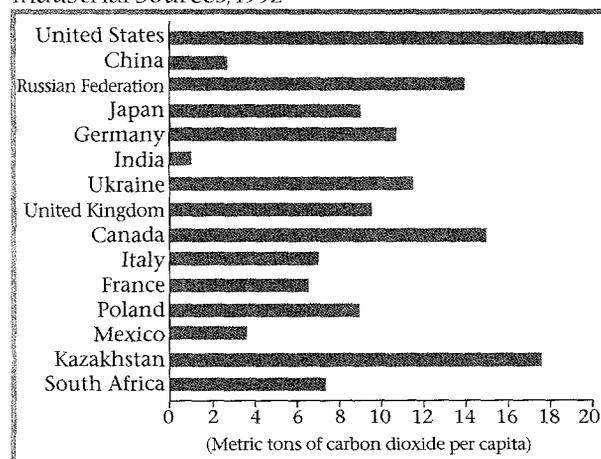
Source: Oak Ridge National Laboratory 1995

1998 Conference of the Parties in Buenos Aires.

No details were approved with respect to either trading or the operation of the clean development mechanism. The appropriate response to non-compliance must also be negotiated. The question of future obligations for developing nations was raised by some industrialized nations, but elicited an angry rejection by developing nations; it too may be revisited in Buenos Aires.

The most important measure of the Kyoto agreement's success may be the impact on corporations associated with the provision of technologies that will greatly influence the future level of greenhouse gas emissions. Will they consider Kyoto a

## 5.3 Per Capita Carbon Dioxide Releases for the Countries with the Highest Total Emissions by Industrial Sources, 1992



Source: Oak Ridge National Laboratory 1995

sufficient sign to begin changing their practices, or will they await further national and international political decisions? For this purpose, the details of the agreement may not be all that important; reduced to its essentials, the message of Kyoto is a relatively straightforward command to begin changing course.

## Technology: Within Our Vision

*The world's energy economic system is a lot like a supertanker, very hard to steer and with very bad brakes, and we know from the science that . . . that supertanker is heading for a reef.*

*John Holdren, White House Energy Advisor*

*The best way to predict the future is to invent it.*

*Alan Kay, Apple Computer*

As experience protecting the ozone layer demonstrates, technological change can be very difficult to initiate but extremely rapid once broad consensus is reached. Once a new direction has been firmly agreed, the economic incentives are to move as quickly as possible. Few firms seek to be the last left producing a banned substance, or failing to comply with a new regulation.

The incentive for change is reinforced by the globalization of the economy, which encourages manufacture for the widest possible market acceptance. Thus, many developing nations, given the latitude to continue using CFCs beyond the time afforded their more developed counterparts, quickly discovered that this grace period was a mixed blessing – because it excluded them from the largest export markets. Multinational firms reinforced the trend by supplier specifications that required “CFC free.” Financial assistance through the Ozone Multilateral Fund further encouraged a more rapid transition.

A similar process may be more difficult to achieve with respect to climate change because carbon is typically embedded in product manufacture and not distinguishable in products and services.

However, the fundamental benefit of cleaner and more energy efficient production potentially holds similar allure. The policy challenge is to find different paths to the same end, channeling the enormous creativity and resources of the private sector to the search for carbon alternatives.

The initial challenge of reducing greenhouse gas emissions is as much political as economic, as much about how we organize our economies as about how much we consume. The IPCC and numerous national reports have shown that there is no shortage of cost-effective technologies for achieving sizable reductions in greenhouse gas emissions.

For example, the IPCC estimates that the market potential for GHG emission reductions in the building sector – the reduction that can be achieved economically with current technologies and no new policies or measures – is 10-15 percent in 2010, 15-20 percent in 2020, and 20-50 percent in 2040 relative to baseline scenarios. The estimates for the transportation, industrial, and power sectors are scenario and nation specific but reach similar conclusions.

These opportunities exist today in virtually all nations, including developing economies and nations that are already relatively energy efficient. For example, China's energy intensity (the ratio of commercial energy consumption per unit of GNP) has fallen 50 percent since 1980, an unprecedented rate over such a period. (China remains four times as energy intensive as the United States, however, making it among the world's least energy efficient economies.) An important reason for China's progress is the recognition that its continued economic success requires the gradual elimination of fossil fuel subsidies, a philosophy increasingly accepted by many developing nations.

A recent analysis by the World Resources Institute notes that between 1990-91 and 1995-96 total fossil fuel subsidies in 14 developing countries

## Energy Comparisons

The United States wastes as much energy producing electricity as the total used annually in Japan. The CO<sub>2</sub> emitted annually from American cars is equal to the total CO<sub>2</sub> emitted by all sectors in India.

accounting for a fourth of global carbon emissions from industrial sources declined 45 percent, from \$60 billion to about \$33 billion. They estimate these reductions reduced otherwise likely carbon emissions by 46 MtC, equal to 9 percent of their 1992 emission levels. The Asian economic crisis may accelerate this trend as Indonesia announced reduced fossil fuel subsidies as part of a package of economic reforms.

Reductions in greenhouse gas emissions are likely to bring considerable ancillary benefits, potentially offsetting much of the costs. For example, the World Bank has recently estimated that in 1995 air pollution in China, primarily attributable to poorly controlled burning of coal, caused 178,000 premature deaths, 1.7 million cases of chronic bronchitis, 1.6 billion restricted activity days, and more than 5 billion cases of respiratory illness.

Improved energy efficiency also benefits development through reduced capital needs for hard currency for power plants and related energy infrastructure, now estimated at about \$100 billion annually in developing nations.

Many candidates for this longer term technological transition have been identified and some have already begun to penetrate the market. For example, wind energy systems are improving rapidly and in ideal conditions already compare favorably with conventional coal burning power plants. Direct conversion of sunlight to electricity is now possible with photovoltaic (PV) and solar thermal technologies. While relatively expensive today, they are already competitive in areas remote from

## Technologies Poised to Make a Difference

1. Fuel cell-powered cars and buses that substantially reduce local pollution, greenhouse gas emissions, and oil consumption.
2. Microturbines (building-sized power plants) with lower costs and equivalent efficiency to current scale coal generation.
3. Oxy-fuel firing (combustion using oxygen rather than air) for manufacture of glass, steel, aluminum, and metal casting, reducing energy use up to 45 percent and dramatically reducing local emissions.
4. "Zero energy" buildings that minimize energy requirements and produce more on-site energy (e.g., through photovoltaic roof-tiles) than is purchased.
5. High strength, lightweight materials that allow reduced costs and improved efficiency in all transportation modes.
6. Coal gasification combined with CO<sub>2</sub> capture and sequestration to achieve high efficiency, clean burning of coal with near zero carbon emissions.
7. Wind power systems combined with compressed air energy storage at a total cost competitive with coal generation.
8. Generation of electricity directly from sunlight through photovoltaics integrated with roofing materials at a cost competitive with central station power.

Source: Report of the Energy Research and Development Panel of the President's Committee of Advisors on Science and Technology, *Federal Energy Research and Development for the Challenges of the Twenty-First Century* (Nov. 1997).

electric utility grids. The costs of these technologies are likely to decline significantly over time because of their small scale, which allows economies of scale and learning by doing.

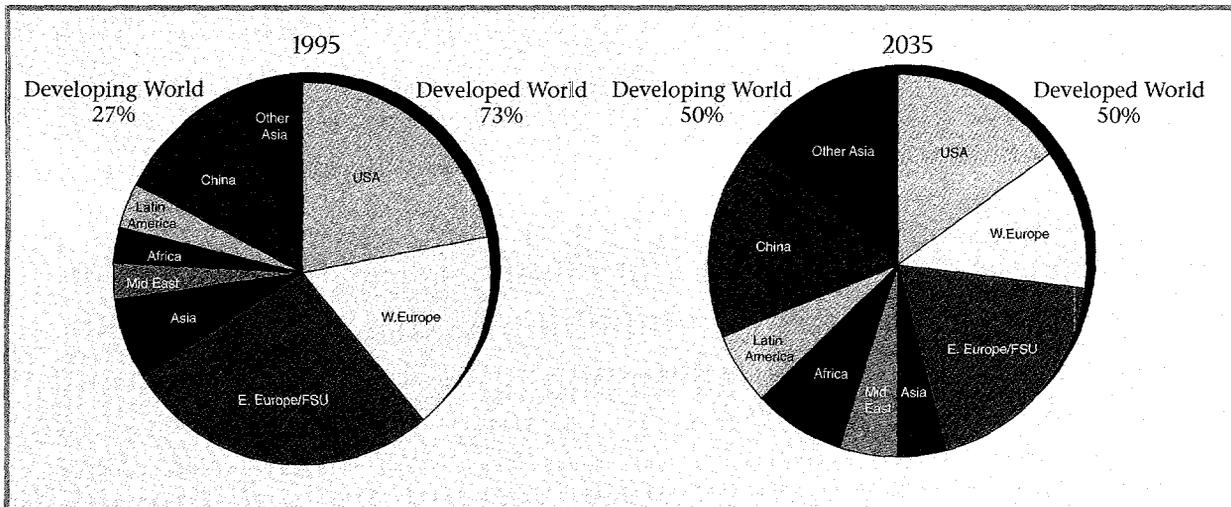
A recent detailed examination of these opportunities was performed by five national research laboratories of the U.S. Department of Energy. They concluded that, relying primarily on already proven technology, the United States could reduce its carbon emissions by almost 400 million metric tons in 2010, or enough to stabilize U.S. emissions in that year at 1990 levels with savings from reduced energy costs roughly equal to the added cost of investment.

Resources and policies to increase investment in renewables and other longer term technologies will be needed. Good examples from the industrialized nations include: a policy in the United Kingdom that reserves a small part of electricity demand for competitive acquisition of designated renewable energy technologies; wind power purchase programs in Denmark and Germany; the "10,000 rooftops" PV program in Japan; and the evolution of "green marketing" campaigns in the United States and Europe to capture consumer willingness to pay modest premiums for electricity from clean energy technologies.

There will also continue to be a need for financial and technical resources to develop and disseminate new technologies in developing nations. The GEF's portfolio of climate projects is so directed and has already been an important contributor to the mobilization of resources for photovoltaics in rural areas, biomass gasification, fuel cell buses, and other emerging technologies.

Traditionally, developing nations have been slow to obtain new technologies until fully proven and available from multiple suppliers in more industrialized nations. This will not suffice if we are to successfully address global warming, since the largest markets and best economic environments will often be in the developing nations; for example, the best opportunity for short term deployment of

## 5.4 Relative Global Emissions of Carbon Dioxide



Source: OSTP 1997; IPCC, IS92A Emission Scenario

PVs may be in rural areas of tropical developing nations remote from electricity grids.

The technological relationship between industrialized and developing nations is also much more intertwined than suggested by the rhetoric of climate negotiations. Developing countries with the most rapidly rising emissions are also the recipients of much of an enormous recent increase in foreign direct investment (from less than \$50 billion in 1992 to more than \$250 billion in 1996). The most greenhouse intensive sectors, including automobiles and power plants, are also among the most closely linked to imports of technology and capital from the OECD. For example, China is developing a domestic automobile industry through joint ventures with most of the major European, Japanese, and American manufacturers.

The short-term nature of climate negotiations and economic forecasts makes it easy to overlook the fact that we live in a time of accelerating rates of technological change. The long term nature of climate change is a challenge to current policy but it also allows for a much wider range of technological opportunity. Climate change modeling is typically done on the basis of increases over several decades, a much longer time period than the introduction of the modern personal computer.

Alex Trotman, CEO of the Ford Motor Company, has said that the automobile is likely to change more in the next decade than it has in the last 50 years. Electricity systems are similarly beginning radical reorganization and technological change due to deregulation and the introduction of low cost and highly efficient gas turbines. In this dynamic economy, meeting the challenge of climate change may turn out to be much more feasible and beneficial than appears to be the case today.

The negotiations leading to the Kyoto Protocol, as halting and complex as they were, may already have provided a sufficient signal for many investors and industries. Indeed, many companies appear to have anticipated the message and to some extent be ahead of the diplomats.

Prior to Kyoto, two of the world's major oil companies, BP and Shell, announced substantial increases in their investments in renewable energy technologies. Toyota displayed its new, commercial model 66 mile-per-gallon hybrid vehicle (combining an electric motor and gasoline engine). Only a few days after Kyoto, Ford announced a new joint venture with Mercedes to produce fuel cell cars as soon as 2004. Whatever happens in future climate negotiations, the Kyoto legacy may be its contribution to these headlines.

## UNDERESTIMATING THE THREAT

Severe climate change is not an unprecedented event. Put in historical perspective, the rates of change predicted in the worst-case scenario by the IPCC are still below those experienced on Earth as recently as 10,000 years ago.

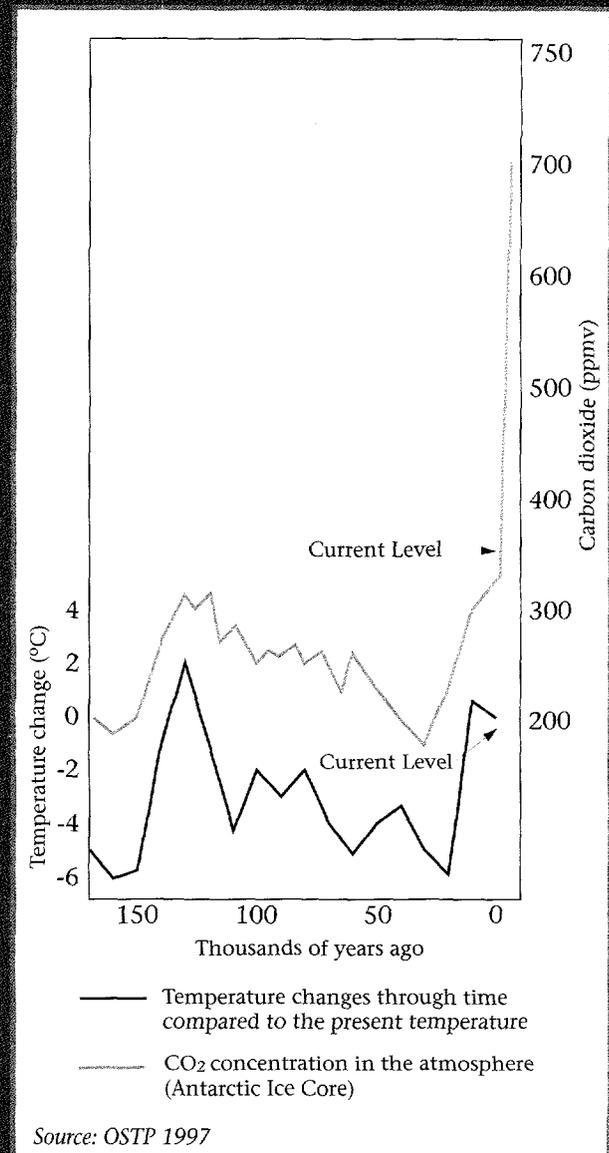
Towards the end of the last ice age – in a period known as the Younger Dryas – as ice sheets were in full retreat and human civilizations were about to benefit from an exceptionally long period of relative climatic stability, the global climate system suddenly shifted. The retreating ice sheets began growing; forests that had recolonized much of Europe were replaced by tundra grasslands; average temperatures near Greenland dropped by more than 10 degrees Celsius; and glaciers in the Andes moved some 1000 meters closer to the ocean. All of this took place in a geologic eye-blink, just 200 years.

This period lasted a millennium, prompting renowned climatologist and oceanographer Wallace Broecker to refer to it as the equivalent of a 1,000 year El Niño. Then, in an astounding twenty years, the process ended: glaciers retreated, forests began to recolonize Europe, and humans began cultivating crops. In some parts of the world, climates warmed at a rate of 1.4 degrees per decade, or 7 degrees per fifty years. (In contrast, the IPCC worst-case scenario predicts an average warming of 6 degrees by 2100).

Though there are a number of different theories of how such rapid change occurred, they all have their roots in the inherently complex nature of the global climate system, a system that is impacted by innumerable factors, large and small. Through positive feedback channels, large changes can result from the relatively small forcings of these factors – such as a rise in CO<sub>2</sub>, methane, and other gases – resulting in a dramatic shift from one climatic equilibrium to another in lightning speed.

When atmospheric scientists program their circulation models to predict the world's climate regime over the next century, they make assumptions about as many of these factors as possible. But when climate change is debated as a policy concern, the unspoken assumption is that the current climatic system can handle a doubling or even a quadrupling of CO<sub>2</sub> levels without “jumping” to an entirely new equilibrium, perhaps one of greatly increased temperatures. As the evidence surrounding the Younger Dryas suggests, this may be a dangerous presumption.

### 5.5 Atmospheric Carbon Dioxide Concentration and Temperature Change



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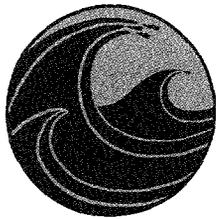
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# PARTNERSHIPS TO SUSTAIN INTERNATIONAL WATERS



*Clouds and rivers are also oceans – temporarily on loan to the atmosphere and to the sea-bound land.* Rolf Ederberg

Water covers more than three quarters of the Earth. It nourishes our ecosystems, powers our industry, grows our food, and makes life itself possible. Yet the image of a “blue planet” is deceptive. Beneath the surface, a crisis of global proportions is building.

Half a billion people are stressed by scarce water supplies today, and by the year 2025 that number is projected to rise five fold. This projection tells only part of the story. The water environment hides another world – of wetland, aquifer, river, and ocean ecosystems that provide trillions of dollars of benefits each year. These life-support systems are now being impaired by overfishing, loss of floodplains and wetlands, increasing discharges of pollution, filling of rivers with mud from deforestation and land erosion, and flow reductions caused by wasteful irrigation practices and dam construction.

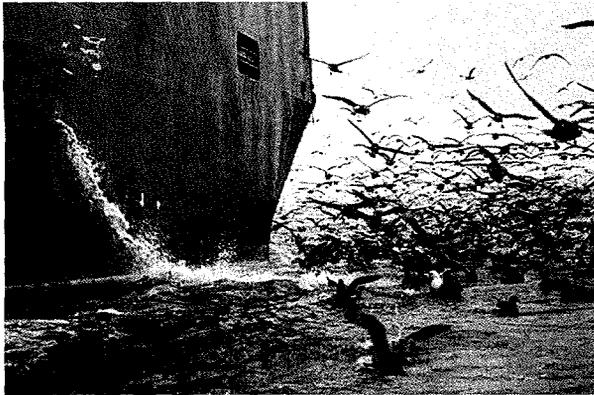
For a quarter century, the scientific community has warned that the degradation of marine, coastal, and river ecosystems is expanding beyond national borders. Water problems that were local in scope have crossed boundaries, inextricably linked through the global hydrologic cycle to

urbanization, watershed degradation, deforestation, biodiversity loss, and climate change. These interrelationships often involve geopolitical concerns, regional and global markets, and monetary and other policies that support subsidies, exports, and trade.

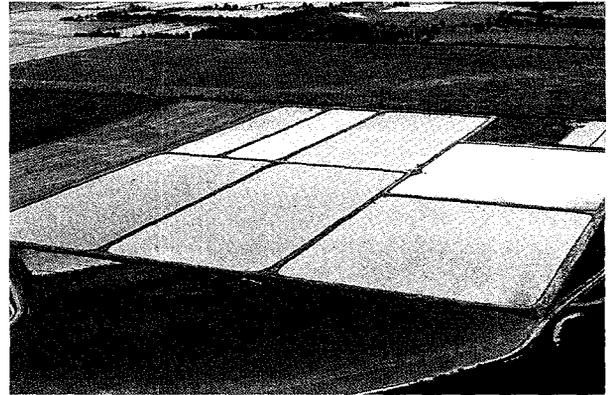
This chapter describes the nature and extent of the growing crisis affecting international waters and their basins. The crisis results, not from the vagaries of nature, but from weak institutions, government policy failures, and market distortions. Water is an issue today because we have failed to:

- Adopt the institutional and regulatory reforms necessary to protect the functioning of the water environment.
- Make necessary water saving and pollution reducing infrastructure investments in irrigation and municipal water/wastewater subsectors to correct adverse environmental impacts.
- Reform the sector by sector exploitation of water resources and their living ecosystems that represents the root cause of accelerated degradation.

A basis for international action does exist. First, lessons have been learned and best practices identified from joint management of transboundary water resources. While much of this experience comes from industrialized countries, developing nations are adding to our knowledge, particularly through GEF-supported partnerships protecting freshwater, coastal, and marine ecosystems. Over



*Factory fishing*

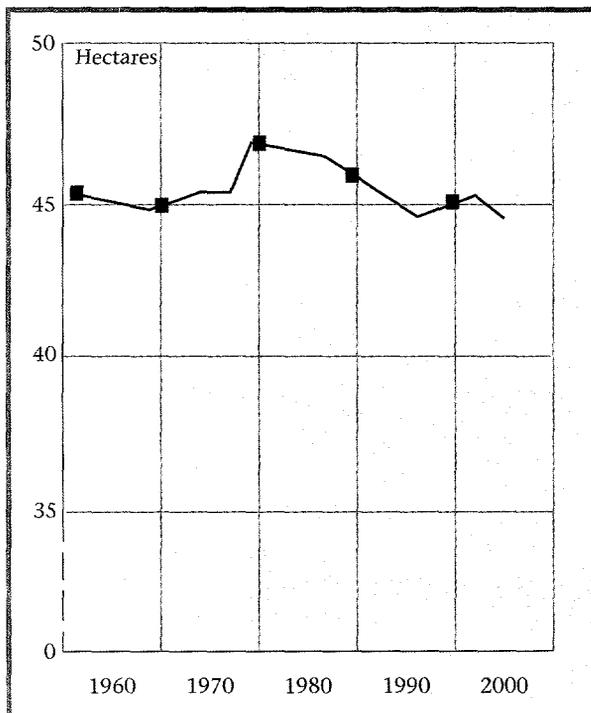


*Aquaculture*

100 countries are undertaking or completing preparation of GEF international waters projects. Experiences from these first generation efforts, as well as those in biodiversity, are adding to the knowledge base.

Second, global and regional agreements have been established regulating navigation, fishing rights, wetlands protection, water allocation procedures, reduction of transborder pollution, and contamination of marine waters. However, this common

### 6.1 World Irrigated Area per Thousand People, 1961-1994



Source: Brown et al. 1997

global understanding is clouded by complexity, as well as by its patchwork nature. Implementation has been hindered by the limited efforts of the North, lack of additional finance, and the need for greater commitment from the South.

New prominence was accorded these issues at the 1997 Special Session of the UN General Assembly and in assignments given the Commission on Sustainable Development for 1998 and 1999. This momentum must not be lost. Industrialized countries, international finance institutions, and the United Nations system are well placed to lead the way in forming new partnerships with governments, the business community, and NGOs to attack the global water resources crisis. A new political commitment is needed to implement existing agreements, along with additional resources to spur reforms and provide needed technology.

## The Urgent Nature of the Issues

“International waters” as used here refer to transboundary water resources, including shared waterbodies, multi-country river or groundwater basins, and ocean areas with common borders. The common global hydrologic cycle links many watersheds, groundwaters, estuaries, and marine ecosystems through transboundary movement of water, pollutants, commerce, and living resources.

The vast majority of the world's population lives near water, and the result has been a disproportionately high human toll on nearby coastal and marine waters. This is the most biologically active and sensitive part of the oceans; over 95 percent of all fisheries caught in 49 "large marine ecosystems" make up the nearshore oceans and enclosed seas (Map, pp. 122-3). Major transboundary river basins cover more than half of Earth's surface and contain at least 40 percent of the world's population. Asia, Africa, and South America have at least two thirds of their land area in multi-country basins.

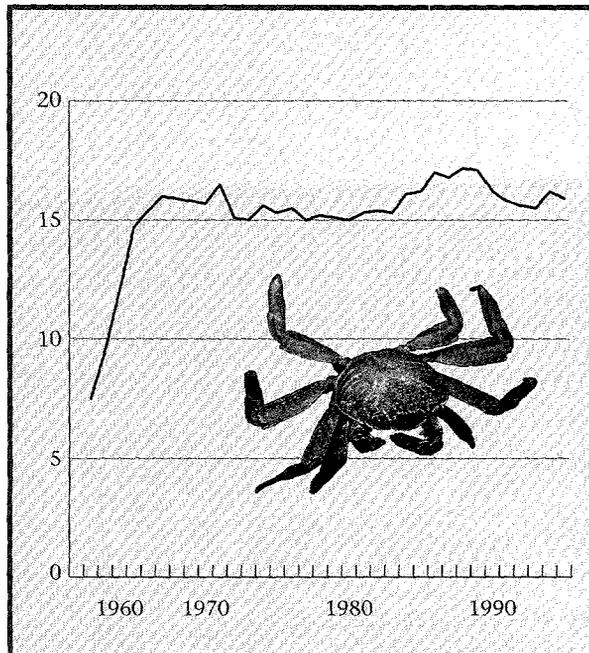
The urgency for action has four basic dimensions:

- Global water resource depletion, related to scarcity of water, overexploitation of fisheries, rules of access, and competition among countries that share water resources.
- Worldwide decline in water quality from on-site and land-based pollution – especially sewage and fertilizers – water toxicity, and contaminants in ship ballast water.
- Degradation of watersheds and wetland habitat related to deforestation, poor agricultural practices, conversion of wetlands, and damage to aquatic and marine life habitat.
- Poor management as well as state institutional and policy failures due to mismatches in multi-country and multisectoral management of shared water resources, including government policy failures, market failures, and a lack of commitment to infrastructure investments.

## Depletion of Global Water & Fishery Resources

Conflicts over freshwater use and the related depletion of transboundary river flow are closely linked to food production. The water environment provides 16 percent of the world's protein, with Asia and Africa relying on fish protein for close to one third of an average diet. Irrigated agriculture accounts for 93 percent of water consumed by all sectors.

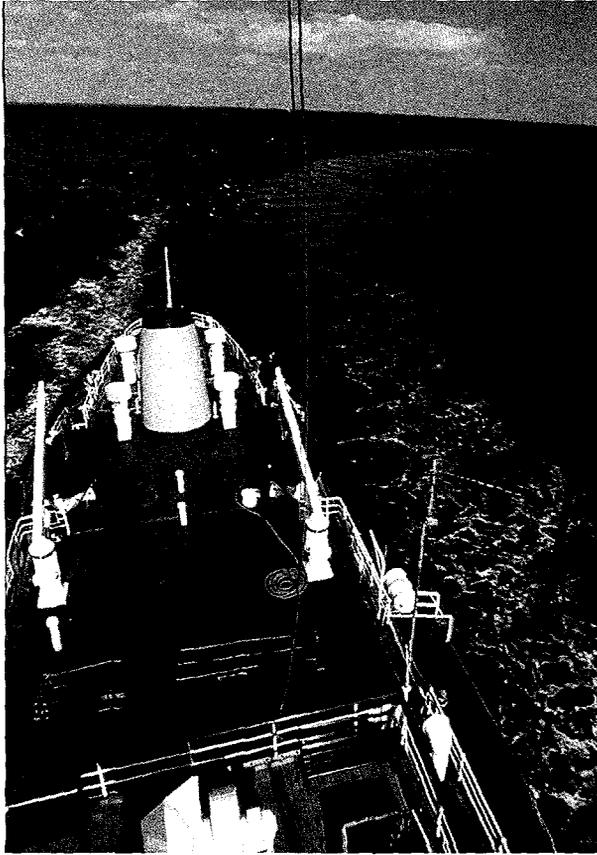
### 6.2 World Fish Catch per Person



Source: Brown et al. 1997

Water supply conflicts often center around proposed irrigation, urban supply, or hydropower projects. These concerns grow more serious and affect more regions as rapid population growth fuels demand for a 50 to 75 percent increase in the world's food supply. Water use for irrigation doubled during the 1970s "Green Revolution." With the annual loss of irrigated land to waterlogging and salinization, irrigated area per person has declined significantly – now approximating the levels of the 1950s (Fig. 6.1). Future irrigation demands will seasonally dry up more rivers and damage more coastal ecosystems.

An even more urgent problem is the unsustainable exploitation of marine fisheries. The rush by countries to exploit fish stocks by oversubsidizing industrial fishing fleets is socially, economically, and environmentally unsustainable and places the future of fishing communities at risk. The global economy spends \$124 billion each year to land \$70 billion worth of fish. Large marine ecosystems are in drastic decline, with three quarters of marine fisheries fully fished, overexploited, depleted, or slowly recovering from collapse. Open



access without effective management regimes mean that too many modern boats are chasing too few fish as the profit motive overshadows the collective good. This feeds tendencies to overfish, under-report the catch, and poach.

Even with modernization of fleets and the marine equivalent of "forest clearcutting," the world's fish catch per person has declined from peaks in the 1980s to the levels of the 1960s, before the great fleet modernization occurred (Fig. 6.2, p.113). The decline in fish stocks since 1983 is evident, with the increase in total catch coming from a few low-value species that are used for feed and fertilizer instead of direct human consumption. Over 40 percent of the world catch is inefficiently converted to oil and meal to feed livestock, poultry, and cultivated fish; subsidized fleets fish lower and lower on the food chain with adverse ecosystem impacts on biodiversity.

This global environment problem promises to

penetrate societies dependent on coastal and marine ecosystems, and its transboundary aspects are growing. Stocks are being harvested by more than one country's fleet. The importance of migratory fish stocks is increasingly apparent, with at least 75 percent of the global marine fish catch spending all or part of their life cycles in near-shore waters.

## Worldwide Decline in Water Quality

It is not hard to imagine how more people, more fertilizer, and more industries with inadequate pollution controls over the last two decades have resulted in local pollution problems expanding to transboundary and regional proportions on almost every continent. The result: marine and aquatic life is devastated, human health compromised, sustainable development impaired, and the economies of nations North and South are burdened by increased costs.

Nutrient overenrichment of coastal waters accompanying increased nitrogen and phosphorous discharges from sewage, livestock, and fertilizer has become a global environmental problem. Devastating algae blooms and toxic algae afflict most corners of the globe where people, industry, and agriculture are concentrated. The Baltic Sea had its most widespread and devastating blooms during 1997, after 20 years of inadequate efforts to combat them. The enormous dead zone in the Gulf of Mexico is so named because large algae blooms, fed by nutrients discharged from the Mississippi River basin, deplete the oxygen supply.

Up and down the East Coast of North America similar blooms interfere with ecosystem productivity, composition, and function just as they do off the coasts of Argentina, China, Thailand, India, and in the Black, Yellow, Adriatic, and North Seas. Nations North and South have an urgent need for cooperation to reduce industrial pollution, adequately treat sewage, and reduce fertilizer and livestock pollution from agriculture.

Another more subtle but significant transboundary pollution issue which has reached global proportions involves release of persistent organic pollutants, or POPs. Primarily an affliction of industrialized nations – whose citizens have up to 500 measurable chemicals in their bodies not present two generations ago – POPs are carried around the globe by air and water currents and compound the accumulation of chemicals shown to impact wildlife, fish, and the humans who consume them. These chemicals have intergenerational health effects, undermining the development of the human brain as well as behavioral, endocrine, neurological, and reproductive systems in the developing fetus.

Transfer of contaminants in shipping from nation to nation and harbor to harbor is also a serious global issue. Although discharges and spills have received the most attention, the economic and ecological costs of transferring nuisance species in ballast water are now recognized. Cleanup and control can cost billions of dollars and significant ecological damage to biodiversity results when preventive measures are not taken.

Examples include jellyfish introduced to the Black Sea and zebra mussels to the North American Great Lakes. Red tide organisms, toxic forms of algae, and other contaminants are now exchanged across the globe, harbor to harbor, as countries refuse to implement voluntary guidelines adopted by intergovernmental bodies.

## Loss of Watersheds, Wetlands, & Marine Habitat

To compensate for the collapse in fisheries, governments and private sector speculators have invested in converting coastal wetlands to aquaculture systems, achieving a fourfold increase in production since 1980. This destruction of natural habitat has contributed to the loss of mangroves (50 percent worldwide), reduced the ability of marine ecosystems to produce fish, and resulted in short-term profits often followed by failure and

## The Threat of Persistent Organic Pollutants

Transboundary contamination from mercury, dioxins, polychlorinated biphenyls (PCBs), acidification, and pesticides has long been observed in Europe, North America, and the Arctic. Less well publicized is mercury pollution associated with gold mining in the eight-country Amazon basin and widespread chronic contamination of the Pacific Ocean atmosphere, water, and living organisms from POPs released from Southeast Asia to China and Japan.

In particular, atmospheric deposition and ocean surface currents such as the Kuroshio Current have been found to contain elevated amounts of dioxins, furans, DDT (dichloro-diphenyl-trichloro-ethane), and PCBs. Such POPs are found in species as far-flung as albatrosses from Midway Island in the Pacific to eagles and sea otters on the Aleutians – at or exceeding levels known to cause reproductive problems.

abandonment of facilities within five years. Use of dynamite, poison, and other destructive fishing practices, coupled with population pressures account for immense, essentially permanent, destruction of coral reefs as well as loss of genetic stock and reductions in biological diversity. Destructive trawling rigs devastate soft bottom communities.



# The Spirit of Stockholm

Julio Barberis

Over the last 30 years, I have had to study problems relating to the use and development of international rivers and lakes. In my opinion, the most important event over the entire period was the 1972 Stockholm Conference on the Human Environment, at which I represented Argentina.

The Conference marked a turning point in the relationship between humankind and its environment. It was there that – for the first time in an international forum – scientists concerned with the natural world were able to show the governments of the various nations what “Only One Earth” really meant.

On the whole, national leaders had paid no attention to studies and statistics prepared by technical specialists, and often the main motivation behind their decision-making was political convenience. In Stockholm, the scientists got their message through. They talked frankly, and warned that humanity had to make a radical change in its attitudes toward the natural world. It came to be understood that waste material could not be endlessly dumped into rivers and oceans; that a time would come when the air would be unbreathable if we continued to pollute it; that stocks of fish would decline considerably if we did not allow sufficient time for them to reproduce naturally; and that cropland would deteriorate if groundwater was overexploited.

In the years following the Stockholm Conference, countries have behaved in very different ways. Generally speaking, the developed countries – which bear the main responsibility for pollution and environmental degradation – have shown a greater readiness to adopt appropriate measures; the developing countries have tended to think that the problems were caused by the industrialized nations, and that it was up to them to find solutions.

Nevertheless, the measures adopted by the latter have not succeeded in improving environmental conditions. There has been a deterioration, and everything done so far has been inadequate.

What will happen if Latin America proceeds on a “business as usual” course? Surface water and groundwater management over the last 20 years clearly shows what will happen if the same methods continue to be applied. Water pollution has increased considerably, and it should be noted that there has also been a change in the types of contaminants that occur, some of which now consist of toxic waste from industry. Water-borne diseases that had been long absent from Latin America have now reappeared, including cholera.

Some countries lack hazardous-waste dumps and sewage-treatment facilities. The decline in water quality has affected aquatic flora and fauna, and some ponds and streams are completely choked with vegetation as a result of eutrophication. In certain areas, some species of fish are becoming extinct, leading to ecological imbalances and the overdevelopment of harmful species.

In light of these prospects for the natural world, there has also been a proliferation of laws, decrees, regulations, and orders for protecting the environment in general, and bodies of water in particular. These have been observed and enforced to only a very minor degree.

Any number of procedures and suggestions have been put forward to remedy this situation, providing the themes for symposiums, conferences, seminars, and doctoral theses. I will pick out five of these proposed measures, because they deserve special attention:

- First, my experience tells me that the present system for offering assistance to developing countries, as operated by the international organizations — and particularly the UN and its specialized agencies — should be completely overhauled, because it is not achieving its objectives.
- Furthermore, countries should be persuaded to stop issuing new environmental laws and regulations, and to devote their efforts to enforcing those that already exist.
- Communities should be shown that governments that infringe certain basic rules of environmental protection are in fact guilty of a violation of human

rights, as was determined some time ago by the European Court of Human Rights.

- Education at all levels (primary, secondary, and higher) is supremely important for raising the consciousness of people in general with regard to their relationship to the environment.
- The cooperation of nongovernmental organizations is particularly valuable when such measures are implemented.

Which is the most important of these measures? I would say that it is the education of the community. An educated population, well-informed with regard to the natural world, is a basic prerequisite for changing the environmental policies currently implemented by many Latin American countries.

*Julio Barberis of Argentina has served as ambassador, technical specialist, and international civil servant and arbitrator in Africa, Europe, and Latin America.*



Deforestation, land degradation, and desertification also have global links to international waters as poor land use practices increase the vulnerability of transboundary basins to natural disasters. Examples include deforestation from excessive logging, agricultural cropping practices, agricultural intensification, mechanization brought about by trade pressures, overgrazing, and poorly designed infrastructure and engineered structures. In combination, these activities transform large river basins into hydrologically degraded systems vulnerable to floods, droughts, and loss of biodiversity. With diminished ground cover and water holding capacity, rains lead to floods, and subsequent low flows result in water scarcity and ecosystem damage.

## State Institutional, Policy, & Market Failures

The most widely recognized international waters problems relate to multi-country, multi-sector competition for water supplies in large river basin systems and multi-country, multi-fleet competition for dwindling marine fisheries. Conflicts among nations over competing uses of these shared waters are widespread and well known, as are mismatches in domestic and international policies and institutions that fail to translate transboundary environmental needs into domestic policies, programs, or investments.

The root of the problem in comprehensively approaching international waters problems remains an institutional one. Fragmentation of responsibility for different sectors and activities affecting water systems is a major problem confronting most countries at both national and local levels. Too often, competition among users is addressed only at the margins of sectoral policies, if at all. National water policy decisions are further complicated by the allocation of authority within each country among national, state or provincial, and local levels of government, and arrangements for incorporating the knowledge and concerns of affected users at all levels are in

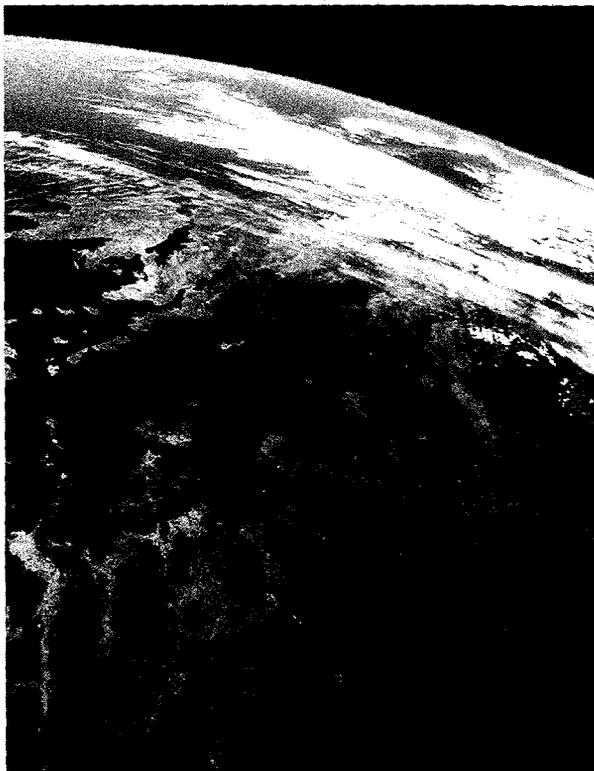
# Technology Cooperation

*Elizabeth Mann Borgese*

Since climate change, the depletion of the ozone layer, and biodiversity loss, as well as sustainable ocean management, are global issues, it is obvious that the industrialized countries of the "North" cannot deal with these issues successfully without the full cooperation of the "South." It is also universally recognized that poor countries need assistance in the development of their human resources and the acquisition of the technologies required for this cooperation.

This is recognized in the Law of the Sea Convention, which provides for technology cooperation at national, regional, and global levels, as well as in each and all of the conventions, agreements, and programmes emanating from the United Nations Conference on Environment and Development. Each one of these instruments contains articles mandating technology cooperation and prescribes means for its implementation.

This is undoubtedly a big step forward. But the fact



that each instrument creates its own systems for technology cooperation, in its own sector, is bound to generate duplication of efforts. The required technologies, basically, are the same for all. What is needed, therefore, is one effective system of technology cooperation serving the needs of all the new conventions, agreements, and programmes, in a flexible and decentralized manner.

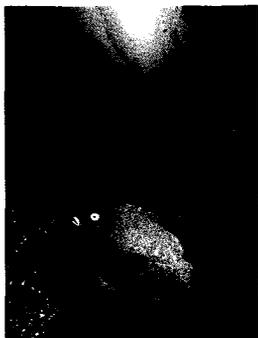
Such a system could be created through the implementation of Articles 276 and 277 of the Law of the Sea Convention, mandating the establishment of Regional Centers or systems for the advancement of marine science and technology. This should be done within the framework of UNEP's Regional Seas Programme, which has started on a process of revitalization. This includes the revision of the Barcelona Convention and the Mediterranean Action Plan, and the establishment of the Mediterranean Commission on Sustainable Development, as well as UNEP's initiatives for the implementation of the Global Programme of Action.

These systems should be based on the most advanced concepts of technology development, generating a synergism of investments from the private and the public sector, at the regional level. They should be conceived and structured in such a way that they can serve the needs of the Law of the Sea Convention as well as all post-UNCED conventions and programmes. They would provide a needed institutional link between all these convention regimes and eliminate duplication of efforts.

A list of priority technologies to be developed/transferred can be gleaned from the conventions and plans of action themselves. They would include: aquaculture and genetic engineering technologies, micro-electronics and information technology, the production of more selective fishing gear, waste recycling, water treatment technologies including sewage treatment, and renewable energy from the sea such as methane production by deep-sea microbes. Lists would have to be refined region by region, according to need.

A possible model was elaborated by the International Ocean Institute, in cooperation with UNIDO and UNEP in 1979. The model embodies the principle of joint technology development or

technology co-development through joint ventures in research and development. This is the most cost-effective form of "technology transfer," and suited to the nature of modern high technology, which is



no longer hardware-based but knowledge-based – that is, it cannot be "bought," it must be "learned."

The establishment of such systems of technology-co-development within the scope of a revitalized Regional Seas Programme would be in full accord with the Programme for the

Further Implementation of Agenda 21 adopted by the Special Session of the UN General Assembly, 23-27 June 1997. Paragraph 92 reads: *Governments should create a legal and policy framework that is conducive to technology-related private sector investments and long-term sustainable development objectives.*

*Governments and international development institutions should continue to play a key role in establishing public-private partnerships, within and between developed and developing countries and countries with economies in transition. Such partnerships are essential for linking the advances of the private sector – access to finance and technology, managerial efficiency, entrepreneurial experience and engineering expertise – with the capacity of Governments to create a policy environment that is conducive to technology-related private sector investments and long-term sustainable development objectives.*

Paragraph 93 recommends the creation of centers for the transfer of technology at various levels, including the regional level.

The creation of such a regional system of technology cooperation requires vision and political will. The funding needed is modest indeed. I should think that \$1 million per Regional Seas Programme would suffice to establish the system, which would be self-financing once established. This would be an investment that would greatly contribute to concerted and effective action on climate change, biodiversity, international waters, and ozone depletion.

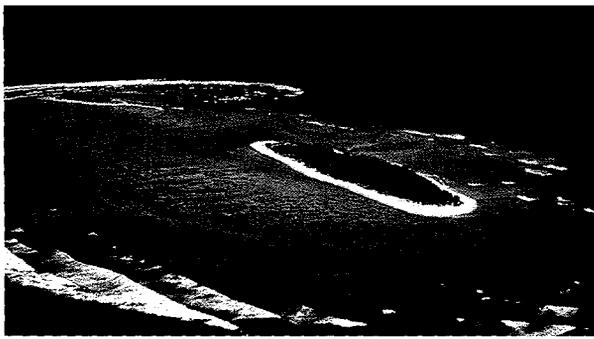
*Elizabeth Mann Borgese is Founder and Honorary Chair of the International Ocean Institute.*

## El Niño and Floods in the Plata River Basin

El Niño, the periodic warming of the Central Pacific Ocean, has been associated with consistent patterns of drought and floods around the world. During El Niño years, drought plagues the Amazon and Northeast of Brazil, India, China, Indonesia, southern Africa, and Australia, while devastating floods occur in East Africa, California, the grain belt of Canada and the U.S., and central portions of South America. Since 1970 a permanent elevation of ocean temperature has been recorded in the Central Pacific, which may signal a new plateau and possible perturbation of the El Niño phenomenon.

Researchers at the World Bank recently undertook statistical analyses of El Niño events going back to 1877 and a century of river flow and precipitation data. They found that current rainfall is heavier in the five-country Plata River basin in South America during El Niño events of the last two decades compared with levels 100 years ago. This intensification is evident in "billion dollar" floods in the two most powerful events on record (1982-83 and 1991-95) as well as additional floods in the 1997-98 El Niño event, which followed on the heels of the century's warmest year.

Rain falling upriver in Bolivia, Southern Brazil, and Paraguay contribute to devastating floods in Argentina, forcing the need for expensive loans to build dikes against the flood waters. Other factors may be conversion of forests to cropland and a series of reservoirs lacking storage capacity for floods. Nonetheless, increased flood peak flows are statistically associated with heavier rainfalls in much stronger El Niño events of the late 20th century.



*A living coral atoll*



*Dead coral used for making cement*

need of improvement. Rival international agencies may intensify the problem if there is no attempt to coordinate project development and consider impacts on water resources in an integrated manner, and donors often prefer to negotiate on a bilateral rather than regional basis.

It is fruitless to address problems of international fragmentation in transboundary waters without at the same time addressing national fragmentation. International problem solving must draw together the government ministries responsible for different sectors, and it must ensure communication with sub-national governing bodies and stakeholders. These institutional barriers are not easy to overcome due to their inherent interconnectedness and complexity. Breaking down water-related problems into smaller, manageable units can be helpful once priorities have been identified at the transboundary waterbody level. Smaller sub-regional, bilateral, and national/local arrangements may effectively target distinct problems within the larger water systems.

These state institutional failures are underpinned by policy failures in regulating sustainable use of waters, fisheries, habitat, and pollution discharges. Market failures drive this continued overexploitation along with billions of dollars of government subsidies and the globalization of the world's economy. Governments have chosen not to make the priority infrastructure investments in irrigation water use efficiency and water supply/sewage treatment that could ease this man-induced global water crisis. Without proper pricing policies, regulatory reform, and infrastructure investments, the crisis will worsen as governments continue to

allow transboundary waters to be used as a dumping ground for pollutants, wetlands to be converted, and fisheries to be overexploited.

## Transboundary Waters & Social Issues

The complexity of international waters issues and their ties to other global environmental considerations, such as biological diversity, land degradation, and economic globalization, require site-specific transboundary solutions. Given fragmented institutions, policy and market failures, and multiple country involvement, the slow progress in cooperative management of transborder waters can be understood. Yet these problems can no longer be ignored because the costs of inaction fall heavily on a large and growing population.

Three factors distinguish social issues affecting communities within transboundary waters: differences in the nature and degree of demographic pressures on the resources; vulnerability of local communities to externally-introduced threats; and more complex property rights and rules of access and management.

Demographic pressures increase competition over resources and hasten depletion. They stem from population growth in coastal and riparian areas and may be intensified by in-migration. In some countries, transborder migrant and refugee populations add to the pressures created by internal migration to the coasts.

Local communities are particularly vulnerable to externally-introduced changes – such as large-scale aquaculture – because they are not in a position to

control them or adjust. Pressures of the global marketplace can exacerbate adverse impacts on communities when governments pursue foreign exchange and export earnings to the detriment of local use.

About one-half of the world fishery catch is harvested by small-scale fleets and artisanal fishermen for domestic markets. The remaining tend to be high value products geared for export. When governments negotiate international agreements, they often allow large commercial fishing operations to encroach on nearshore fisheries, increasing pressure on local resources and eroding livelihoods of low income artisanal fishing communities. Over the long term, depleted stocks and reduced incomes cause increased migration to nearby cities or shift pressure to nearby forests.

Population pressures and increasingly diverse user groups affect both national and transboundary water resources. Rules governing access to and management of resources may differ among communities at the national level. But when more than one country is involved, defining and reconciling problems is complicated by a greater number and range of outlooks, priorities, and legal systems. These communities may have little stake in altering the ways in which water resources are used, especially when government officials do not establish means to ensure that local users' needs are consistently taken into account. If rules are obeyed in one country and ignored in the next, the incentives for continued compliance are diminished.

When pollution and habitat degradation arise from transboundary areas beyond the authority of local communities, their resources and political clout may be insufficient to curtail the problem. A large-scale influx of migrants or refugees – often into unprotected and ecologically fragile sites – will encroach on resource availability and use by local populations. Not only are social and health services and other local government institutions ill-equipped to cope; areas settled by migrants are fre-

quently inaccessible to government workers and extension programs. Juridical, land, and riparian rules and registers are not well defined relative to the numbers and types of competing users, often placing local fishermen at a disadvantage compared with foreign fleets.

The most vulnerable are women and indigenous groups. Indigenous groups along the coast have the least access to social services and are the ones most affected by resource depletion. Gender concerns are important in coastal towns where women and women's groups play key roles in maintaining homesteads, soil and water conservation, and processing fish and marine products. Because international agreements are often made without local consultations, the flow of benefits within and among marginalized ethnic groups and women is not always clearly defined. In the end, these groups benefit the least and suffer the most.

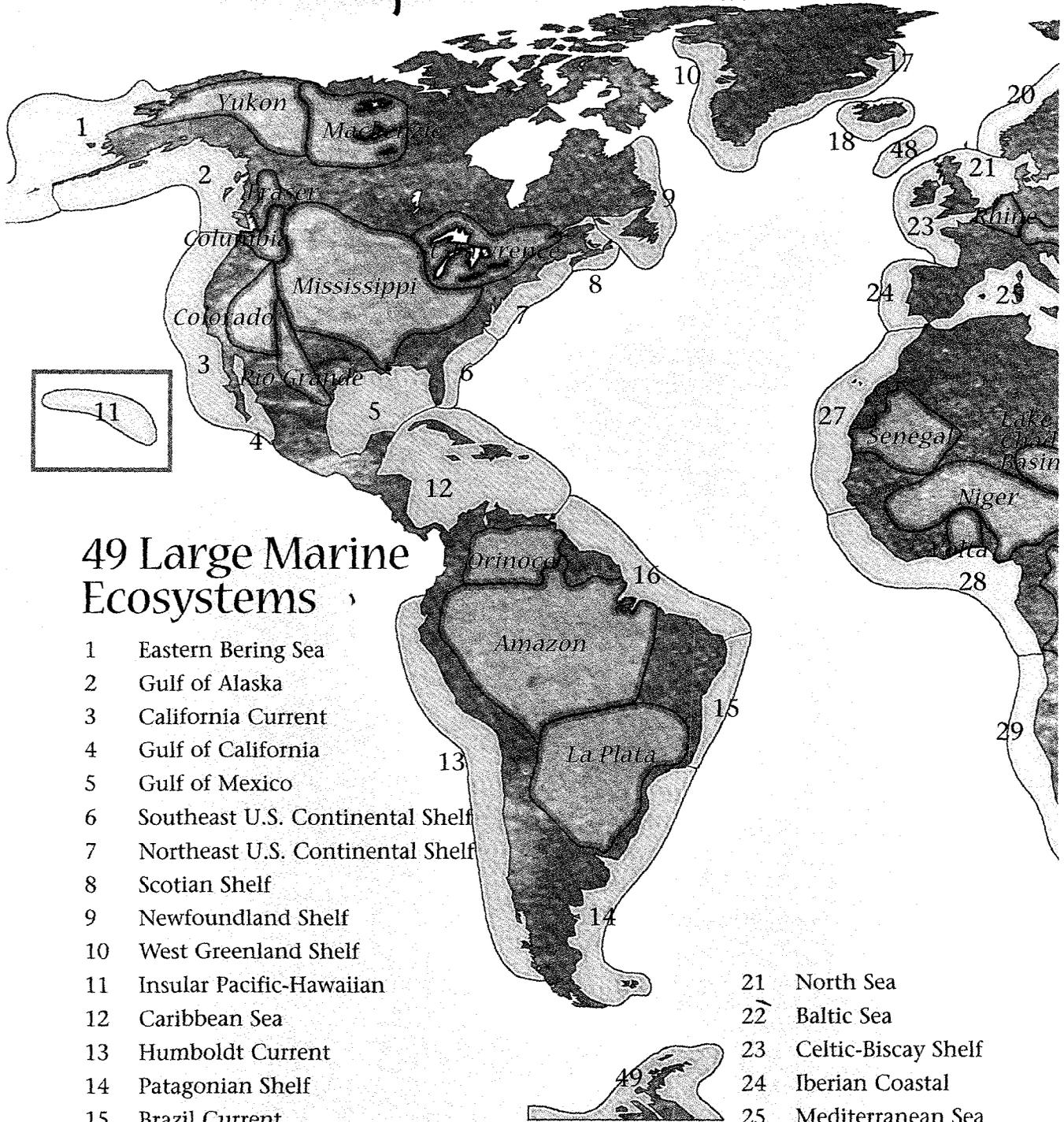
## Land Degradation & International Waters

River, lake, and groundwater basins, which often come under the jurisdiction of more than one

*Sewage spilling out into the North Atlantic*



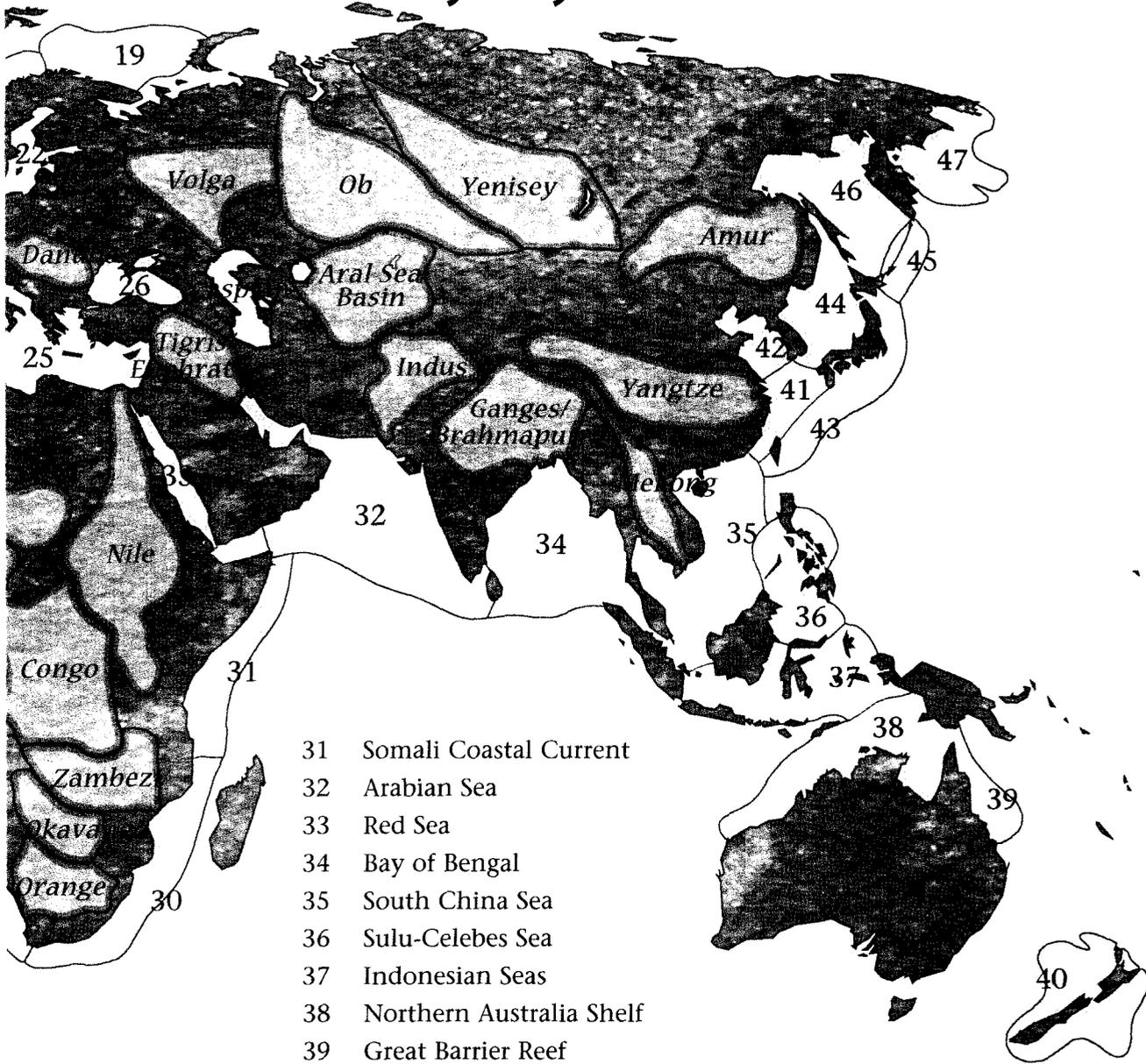
# Major International Waters



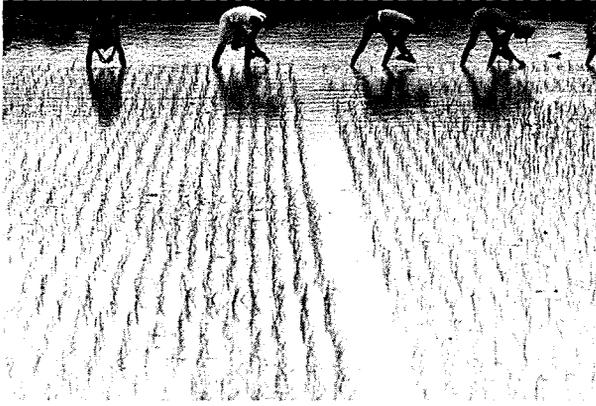
## 49 Large Marine Ecosystems

- |    |                                  |    |                     |
|----|----------------------------------|----|---------------------|
| 1  | Eastern Bering Sea               | 21 | North Sea           |
| 2  | Gulf of Alaska                   | 22 | Baltic Sea          |
| 3  | California Current               | 23 | Celtic-Biscay Shelf |
| 4  | Gulf of California               | 24 | Iberian Coastal     |
| 5  | Gulf of Mexico                   | 25 | Mediterranean Sea   |
| 6  | Southeast U.S. Continental Shelf | 26 | Black Sea           |
| 7  | Northeast U.S. Continental Shelf | 27 | Canary Current      |
| 8  | Scotian Shelf                    | 28 | Guinea Current      |
| 9  | Newfoundland Shelf               | 29 | Benguela Current    |
| 10 | West Greenland Shelf             | 30 | Agulhas Current     |
| 11 | Insular Pacific-Hawaiian         |    |                     |
| 12 | Caribbean Sea                    |    |                     |
| 13 | Humboldt Current                 |    |                     |
| 14 | Patagonian Shelf                 |    |                     |
| 15 | Brazil Current                   |    |                     |
| 16 | Northeast Brazil Shelf           |    |                     |
| 17 | East Greenland Shelf             |    |                     |
| 18 | Iceland Shelf                    |    |                     |
| 19 | Barents Sea                      |    |                     |
| 20 | Norwegian Shelf                  |    |                     |

# including Large River Basins



- 31 Somali Coastal Current
- 32 Arabian Sea
- 33 Red Sea
- 34 Bay of Bengal
- 35 South China Sea
- 36 Sulu-Celebes Sea
- 37 Indonesian Seas
- 38 Northern Australia Shelf
- 39 Great Barrier Reef
- 40 New Zealand Shelf
- 41 East China Sea
- 42 Yellow Sea
- 43 Kuroshio Current
- 44 Sea of Japan
- 45 Oyashio Current
- 46 Sea of Okhotsk
- 47 West Bering Sea



country, are critical to the well-being of more than one billion people who live in areas at risk from desertification. Land degradation in subhumid and humid areas also causes loss of productivity and impairment of aquatic ecosystems in international waters. In view of the growing sediment pollution and salt intrusion in rivers, lakes, and aquifers – caused by deforestation, soil, and vegetation loss, over-pumping of groundwater, and soil salinization – controlling and preventing land degradation is very important to addressing international waters issues.

The interface of watershed management, land-based sources of pollution, and environmental management of regional seas suggests ways to simultaneously achieve international waters and biodiversity objectives, with an emphasis on prevention and control of land degradation.

Aquifers are a major source of water in many dry-land areas, and managing international groundwater basins is critical for sustained availability of freshwater. In North Africa, the Sahel, and Southwest Asia, international aquifers are being exploited beyond their recharging capacity, or they are being polluted, causing basinwide degradation. Countries will be better able to control land degradation through sub-regional cooperation in managing shared aquifers and their recharge areas.

Deforestation and land degradation in international watersheds (for example, the Nile, the Niger, and the Indus) can affect rainfall patterns,

increase the range of local temperatures, and cause major variations in the flows of rivers and streams. International cooperation to maintain stream flows, control land degradation, restore the hydrologic balance of watersheds, and ensure environmentally sound management of waters would help conserve terrestrial and marine biodiversity, enhance carbon sequestration, and raise farm and fisheries productivity.

## Common Institutional Approaches

A great deal of fragmentation exists within legal frameworks available to address transboundary water concerns. In addition to numerous legal agreements, there are various non-binding policy documents, action plans, and strategies adopted by global and regional organizations. Nevertheless, these are international instruments which are available to devise flexible multi-country solutions to transboundary environmental problems that accommodate differences in socioeconomic status, culture, and type of water issue.

This array of agreements and international laws is quite complex, yet there are common threads running through them. What is needed is a better understanding of how one relates to another and how together they may provide a comprehensive framework for action on transboundary water problems. At the operational level, international agencies ideally respond to agreed national and international priorities and coordinate their programs to derive maximum benefit for the beneficiary populations. The reality is that parochial institutions and client ministries and stakeholders often operate at cross purposes. Meanwhile, assistance to help groups of nations willing to cooperate remains inadequate.

Existing legal agreements provide for a continuum from general norms of conduct for all nations and private actors to specific commitments to achieve broad goals and targets (e.g. 30 percent reduction in nutrient input) and agreements on more

detailed sector-by-sector rules, standards, and recommended practices.

Fundamental global norms for conservation of marine resources and preservation and protection of the marine environment are established in the U.N. Convention on the Law of the Sea (UNCLOS), which entered into force in 1994. Detailed rules and standards at the global level exist to control pollution from ships, including at-sea disposal of wastes, and for whales, the one fishery whose target species truly migrate worldwide. Otherwise, the rules on marine pollution and fisheries are regional, in keeping with the scale of marine systems.

A similar situation prevails in freshwater. There are hundreds of international agreements focused on particular transboundary systems. On May 21, 1997, the global Convention on the Law of Non-Navigational Uses of International Watercourses was opened for signature. It establishes a framework and provides benchmark norms for nations to negotiate specific agreements resolving transboundary freshwater environmental problems.

It is critical to appreciate and make use of the interplay between general global norms and specialized agreements of a geographic or activity-specific nature. Global norms, through general principles and objectives, establish parameters for all national and collective action. These are translated into more specific goals and commitments through specialized agreements. Recognizing the need to respond to site-specific circumstances and the particular mix of problems in a given waterbody, specific geographic instruments provide a means to determine priorities and comprehensively address them. At the operational level, these problems may be broken down into more manageable units, and agreement on specialized technical and policy response options promotes harmonized approaches among countries.

Thus, for land-based sources of marine pollution, which includes pollution borne to the sea by



*The Nile Valley*

ivers, the UNCLOS framework calls on governments to elaborate more detailed rules and guidelines and to harmonize policies at the regional level to account for regional differences (Articles 207 and 213). Six regional seas conventions have specific agreements on land-based pollution.

The world community took one step further toward the understanding that nations must address waterbody issues in a site specific manner at the regional level by concluding the Global Programme of Action (GPA) for the protection of the Marine Environment from Land-Based Activities in late 1995 (Box, p. 129). Its comprehensive and logical approach to transboundary waters issues should help nations adopt new institutional arrangements linking freshwater basin management with downstream marine and coastal impacts, such as the revised 1996 protocol on land-based sources and activities for the Mediterranean Sea. This linkage is reinforced by the 1997 Global Watercourse Convention.

Another example of the relationship between global frameworks and specialized agreements may be found in recent fisheries developments. A call for selective fishing gear and practices and a precautionary approach to fisheries management

## Risk Interactions

*Ellen K. Silbergeld, G. Thomas Strickland, and Suzanne Jacobson*

Many human impacts on the environment have global dimensions. In addition to ozone depleting chemicals and carbon emissions modifying global climate, some toxic chemicals have been released into the environment on a scale that has measurably changed the biochemistry of populations of organisms, including humans. Humans now carry levels of lead approximately 100-fold higher than those found as recently as 400 years ago, and the concentrations of mercury in the feathers of pelagic birds have increased over the past century. Most biota also carry measurable amounts of PCBs, DDT and its metabolites, and the chlorinated dioxins and furans.

Additional priority should be placed on toxic chemicals that interact with other global environmental changes because of their effects on host resistance to infectious disease. Exposure to immunotoxic chemicals may modify the response of individuals and populations to the changing epidemiological and environmental context of infectious disease.

The relationship between environmental change and infectious diseases has received increasing worldwide attention since a link was proposed



between global warming and the reemergence of particular infectious diseases. However, little attention has been given to the potential for chemical contamination and exposure to toxic chemicals to effect population response to endemic infectious disease.

Persistent organic pollutants and long range trans-boundary air pollutants have drawn international demands for source identification and control. And, after decades of relative neglect, international attention has also refocused upon the need for new research and intervention to control the major endemic diseases of the world, such as malaria.

But these new programs continue a separation between these two categories of environmental risks, in terms of research, impact assessment, and intervention. The extent to which these risks interact is generally unrecognized. Instead, competition for resources continues, obscuring opportunities to promote health through concerted action that encompasses both classes of risk.

Increasingly, it is the interactions among risks that endanger both the environment and public health. This is especially so when environmental, economic, and social change increase human exposure to chemical and other stresses even as changes in population distribution and in natural ecosystems affect the epidemiological context of pathogens and their vectors.

Mercury, a global pollutant, is highly immunotoxic. Mercury exemplifies the need to attend to global as well as local pollution sources, especially those that are small in each instance, but are widely repeated throughout the earth. Small-scale events summed up over space and time can have global impact.

Until recently, little attention was given to artisanal gold mining as a major input source of mercury, even though as many as 2,000,000 people may be involved in this 'low technology' activity of extracting gold from alluvial deposits by using mercury for amalgamation. This use of mercury may account for between 10-20 percent of total global inputs.

Communities far removed from gold mining regions and persons living long after active gold mining has

## Protecting Against Land-based Activities

Recognition in 1990 that more than 75 percent of coastal and marine water pollution originates from land-based sources stimulated a new round of inter-governmental meetings and consultations, building on UNCLOS and the Earth Summit's Agenda 21. The Global Programme of Action (GPA), adopted in late 1995, represents a significant achievement, not least because it expressly addresses physical habitat modification such as wetland conversion in addition to pollution loading.

Governments set as their common goal sustained and effective action to deal with all land-based impacts on the marine environment as an operational strategy. The GPA identifies actions needed at various levels of society to prevent, control, and reduce the degradation of the coastal and marine environment. It classifies nine categories of concern (such as sewage, persistent organic pollutants, and sediment mobilization), establishes priority action areas, and defines strategies and programs to take advantage of numerous instruments that currently exist.

States declare their intention to: develop or review national programs, implement them, cooperate to build capacity and mobilize resources, take immediate preventive and remedial actions, cooperate on a regional basis, and urge national and international institutions and bilateral donors to accord priority to projects under the GPA. Various objectives, national activities, and regional actions are recommended for each concern.

While most financial resources must come from domestic sources, external sources, such as bilateral donors and international financing institutions, are also expected to cooperate. The GEF is invited to build upon the work undertaken pursuant to the GPA and to fund the agreed incremental costs of activities consistent with GEF's operational strategy.

ended are at risk. Lakes in California are still posted with fish advisories because of residual contamination 150 years after the US "gold rush" of the 19th century.

Many of the regions where artisanal gold mining is most intensive are those where infectious diseases, such as malaria, are endemic. As a result, risk interactions may already be taking place. In addition to mercury contamination, artisanal gold mining further impacts the risks of infectious disease through destruction of habitat, biomass burning, dredging and gouging of stream beds and riparian structures, silting, and erosion of surface soils.

These environmental changes increase breeding sites for the mosquito vectors of malaria and reduce populations of fish that consume insect larvae. The miners create reservoirs of infection, increasing malaria transmission locally and, when they return infected, to their homes.

It is easy to appreciate how the immunosuppressive effects of mercury can increase the incidence and severity of malaria in this scenario. In malarious areas, other populations downstream from the mines can also be exposed to mercury via consumption of fish. Surface waters, and their fisheries, become the nexus for interactions between mercury and pathogen exposure.

These interactions challenge national and international health and environmental agencies to coordinate programs of assessment and intervention, and to investigate the nature and extent of toxic exposures in populations beset by endemic infectious disease. Such institutional and policy changes are difficult, but they can help to maximize investments in both health and environmental protection. Given the importance of artisanal mining as a source of both mercury exposure and contact with vectors of disease, this is a significant opportunity to assess the nature and extent of risk interactions and to design coordinated programs to reduce the impacts of both types of risk.

*The authors are members of the Program in Human Health and the Environment at the University of Maryland.*

at the global level was set out in the 1995 U.N. Agreement on Straddling Fish Stock and Highly Migratory Fish Stocks. Implementing UNCLOS leverages their application and elaboration in particular regional fisheries agreements. As specific improvements are developed and applied at national and regional levels, they may be adopted elsewhere and provide the basis for agreement on more detailed global rules.

Existing international agreements go only part of the way toward attaining the goal of comprehensive problem diagnosis and specialized solutions. Those on freshwater systems rarely integrate water quality with predominant water allocation concerns, nor do they embody the idea of allocating water for environmental services, such as groundwater recharge or freshwater flow to maintain downstream ecosystems. The 1997 Watercourse Convention now remedies this situation in principle, but application at the level of specific transboundary agreements is yet to come. The regional marine agreements for the most part have not linked consideration of pollution with habitat modification and international fisheries.

The North Sea is a major exception, where an integrated assessment is undertaken by a special task force in order to inform regular inter-ministerial conferences. Recent developments in the Mediterranean are encouraging, and initiatives in the Baltic have added overfishing, endangered species/habitat, and genetic loss of wild fish stocks to an agenda once focused exclusively on pollution.

Little by little, a common global understanding has been developed over the last two decades of how to approach complex international waters issues. Some solutions are worked out sectorally at the global level, such as ship-related pollution, general policies on wetlands, or movement and disposal of hazardous chemicals. Others are handled more comprehensively on a site-specific regional basis. While the conventions spell out norms, targets, and measures to be applied, action

plans and programs define operational strategies. The intent of UNCLOS, the GPA, and the 1997 Watercourse Convention is for the global solution to be implemented piece by piece in logical, site-specific, regional cooperative efforts: in the North Sea, the Rhine basin, Lake Geneva, the Danube, the Black Sea, the Wider Caribbean, as well as the Senegal or Okavango River basins.

Non-binding soft law complements binding legal arrangements, helping countries overcome barriers to action. Examples range from Agenda 21 chapters 17 and 18 and the GPA to the action program for Small Island Developing States. The great value of non-binding documents is that they work around the edges of binding commitments to elaborate, guide, and influence action. They may provide a more detailed blueprint, and they may sow the seeds of future binding commitments.

Completing this common global understanding are important links to other global framework conventions such as the Convention on Biological Diversity, the U.N. Framework Convention on Climate Change, and the U.N. Commission on Sustainable Development. In fact, as recognized by the GEF Council, these initiatives provide a new opportunity for cooperating nations to link many different programs and instruments into regional comprehensive approaches to address international waters. Joint multi-country initiatives tackling transboundary freshwater, coastal, and marine issues are essential for achieving the goals of these important conventions.

The world community has at least three decades of experience in Europe and North America with regional conventions on transboundary water and environment issues. Joint activities to address water quantity disputes go back even further. Valuable lessons – positive and negative – have also been learned in the South, some of which are noted in a World Bank funded review of African river basin organizations. With GEF support, the South is contributing new experience through multi-country initiatives focused on site-specific

priorities in shared waterbodies, coastal zones, and river basins.

Experiences from these joint regional activities suggests several lessons:

- Donor-driven rather than country-driven institutional arrangements have proved ineffective.
- Water quality must be considered together with water quantity and ecological considerations in any sectoral development project if sustainable development is to be achieved.
- Ecosystem-based approaches are needed for improving management of transboundary water systems which encompass overfishing, habitat loss, and biological diversity issues in addition to water quality/pollution abatement.
- Interministerial and subnational government involvement is necessary in these joint, multi-country regional initiatives if actual changes in sectoral activities causing the transboundary problems are to be achieved.

This growing body of experience also demonstrates that facilitators or third parties are often necessary to bring nations together to address the issues, help them establish a realistic list of priorities on a strategic, waterbody basis, leverage international community attention and a coordinated response, and keep the initiative from bogging down. Facilitators may be strong voices in academic or NGO communities or those in donor or international finance institutions who can provide funding for multi-country cooperation.

The different governments, sectoral ministries, and relevant stakeholders in each nation must participate from the start so that the initiatives are country-driven. It is also essential to avoid long, all-inclusive wish lists of activities by setting priorities. GEF projects implemented by UNDP, UNEP, and the World Bank provide incremental cost financing, policy support, and resources from their regular programs to help nations target distinct transboundary problems or opportunities key to sustainable development and incorporate needed interventions into their economic and sectoral



## Building GEF Partnerships in the Black Sea Basin Ecosystem

Transboundary environmental problems affecting international waters are so complex, so rooted in environmentally damaging sectoral policies and activities, and so interlinked with multiple stresses that a series of interventions are required over the long-term.

When asked for assistance by countries wishing to collaborate, GEF supports a series of strategic fact-finding, priority setting, and action oriented processes to enable countries to know more about their shared water-related problems, learn to work together, and focus on the important domestic interventions needed for transboundary problem solving. GEF also recommends breaking up complex basins and oceans into more manageable watershed units with a number of GEF projects focused on specific actions.

A good example of partnership is cooperation forged among the 17 countries of the Black Sea basin. Separate GEF international water projects exist for six Black Sea, 13 Danube River basin, and three Dnieper basin countries, and there are additional GEF biodiversity projects in the Danube Delta and other wetlands of the basin. The ecosystem-based approach seeks to generate sufficient catalytic effect to leverage significant on-the-ground action. This nesting of projects demonstrates GEF is serious about helping participating nations make the transition to environmentally sustainable use of transboundary waters. It also works in a coordinated, cost-effective manner with the regular programs of GEF's implementing agencies, bilateral donors, and other multilateral agencies to bring policy dialogue, technical assistance, and monetary resources to bear on the multiple stresses that have decimated the interconnected Black Sea Basin Ecosystem.

development plans.

Experience has also revealed the critical role of the state in undertaking reform that supports more environmentally sustainable policies for water resource management. This role has many facets, beginning with programs that implement responsibilities and obligations under multi-country treaties. All countries are now expected to adopt reforms that promote more holistic, cross-sectoral approaches to water resources management and create necessary regulatory systems for water and fishery rights, allocation processes for water quantity, and water pollution control standards. Elimination of subsidies damaging the water environment can free up additional funding. Investments for necessary infrastructure improvements are essential as are water pricing reforms. We've learned from experience that states must adopt transparent regulatory systems to overcome pervasive market failures, enact pricing reforms, and place high priority on water saving and pollution reducing infrastructure investments if the global domestic and transboundary crises in water resources are to be addressed.

## The Future of International Waters

Without water there is no life, and without water there can be no economic development. While humanity acknowledges that use of water, its wetland margins, and its living resources are the lifeblood of society, governments, the private sector, and communities, people do not treat it as such. Current policies and management practices are not sustainable from any perspective – economic, social, or environmental. While the world's population doubled during the last 40 years, water use tripled. With global population like to double over the next 30 years, there will not be enough clean water, enough wetlands, or enough fish to sustain us all.

In the coming rush to intensify irrigated agriculture with more water withdrawals, convert wet-

lands, and exploit more fish in the exclusive economic zones of developing countries, the risk is great that the water environment, particularly transboundary waters, will be overlooked. More intense sectoral uses will diminish the estimated \$25 trillion in annual benefits from the Earth's natural resources attributable to water-related ecosystems and damage the global natural systems that humans depend on for survival. Intersectoral competition for water resources will increase, and it will be most intense in transboundary situations. With the costs of inaction so high, the world community will be forced to take drastic measures.

The transboundary water environment is a critical component in dealing with the water resources crisis. A new political commitment is essential among neighboring nations for joint management initiatives based on the existing patchwork of agreements. In many cases, the initiatives will drive sectoral reforms at the national level. Policies and activities will need to be harmonized so that unfair economic advantages are not experienced. Multi-country, waterbody agreements will be necessary to lay the groundwork for appropriate in-country sectoral reforms which translate the site-specific transboundary needs into domestic actions.

Despite its complexity and its slow development over the last decade, a common global understanding has developed for strategic approaches that governments may use to address the global water resources crisis and its transboundary aspects. Treaties like UNCLOS, the Watercourse Convention, the Convention on Biological Diversity, soft law, and action programs stemming from intergovernmental initiatives have laid out a road ahead with obligations and responsibilities nations must shoulder.

With the new political recognition of the crisis, it is time for a renewed political impetus to address sustainable development through water resources, which are its most fundamental, cross-sectoral constraint.

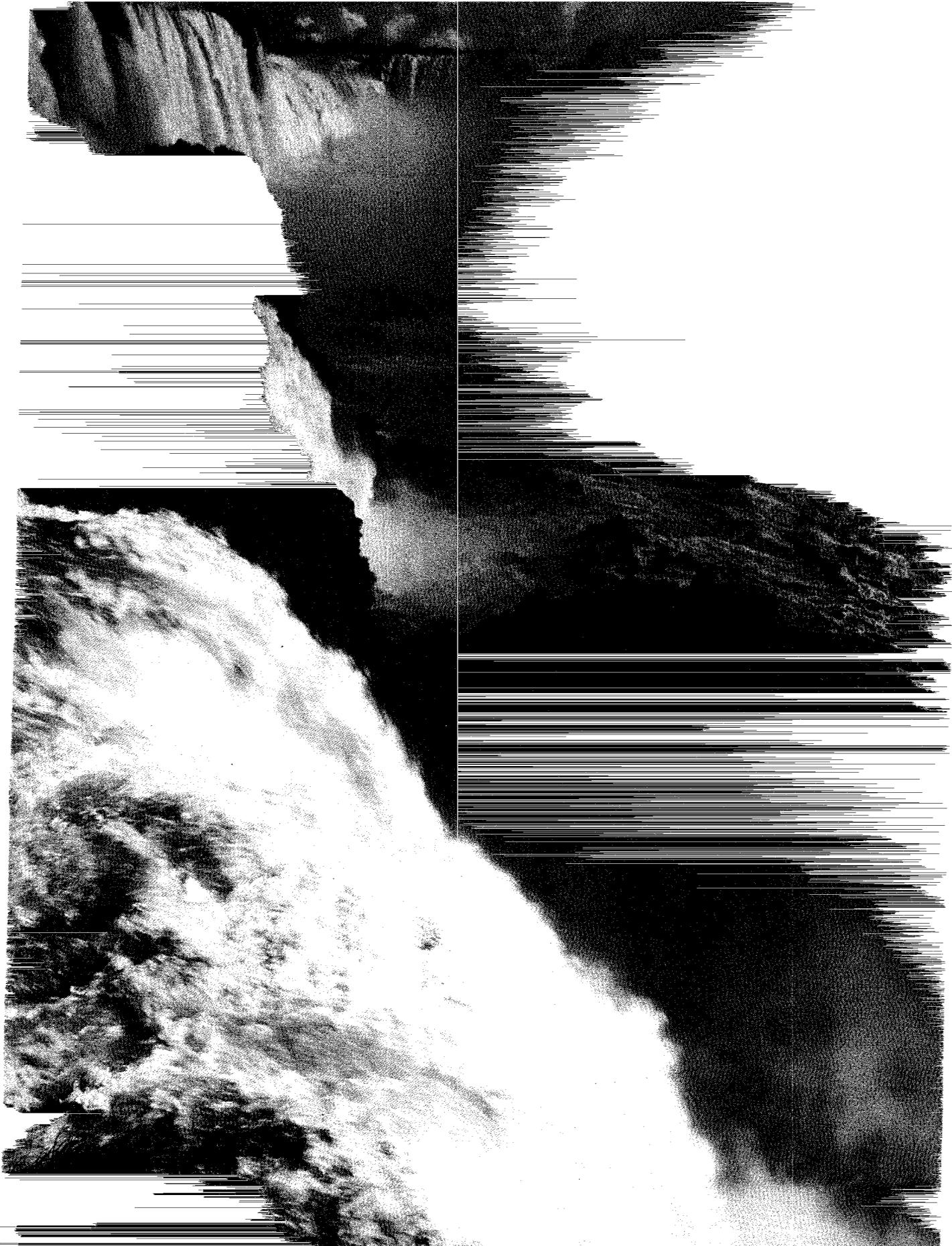
It is now incumbent on industrial nations, international finance institutions, and the UN system to take leadership in forming new partnerships to make the necessary reforms and to provide incentives to resolve their transboundary problems. Their responsibility doesn't end there. They will be called on to provide additional finance and technology to catalyze the South's participation in sustaining the transboundary water environment as part of a global commitment to sustainable development. Research and educational institutions, NGOs, and the business community will be called on to be active partners with the North and the South. The press will be called on to mobilize communities and citizens to undertake their role.

Nothing short of a high level political commitment and the necessary resources can harness these diverse partners on behalf of the transboundary water environment. Nothing less than a global effort to restore and protect the ecological functioning of transboundary water resources can provide sufficient focus to forestall the global water crisis facing our "blue planet" at the dawn of the millennium.

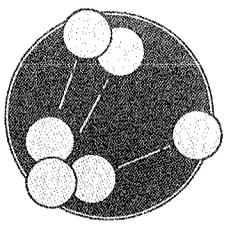
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# LESSONS from the OZONE HOLE



The global effort to protect the stratospheric ozone layer provides a variety of hopeful lessons for global environmental protection.

First and foremost, the scientific community confirmed conclusively by 1989 that ozone depletion was linked to human activities and posed an immediate threat to human health and the global environment. Over a relatively short time, scientists showed that a group of chemicals – including chlorofluorocarbons (CFCs) and halons – were the first link in a chemical reaction that was aggressively destroying ozone in the stratosphere.

Second, environmental advocacy groups, the scientific community, the media, and NGOs generally played a key role in influencing public, private, and governmental action, which led – even before clear confirmation by scientists – to the 1985 Vienna Convention on the Protection of the Ozone Layer and then to the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer.

Many other lessons are noteworthy, including:

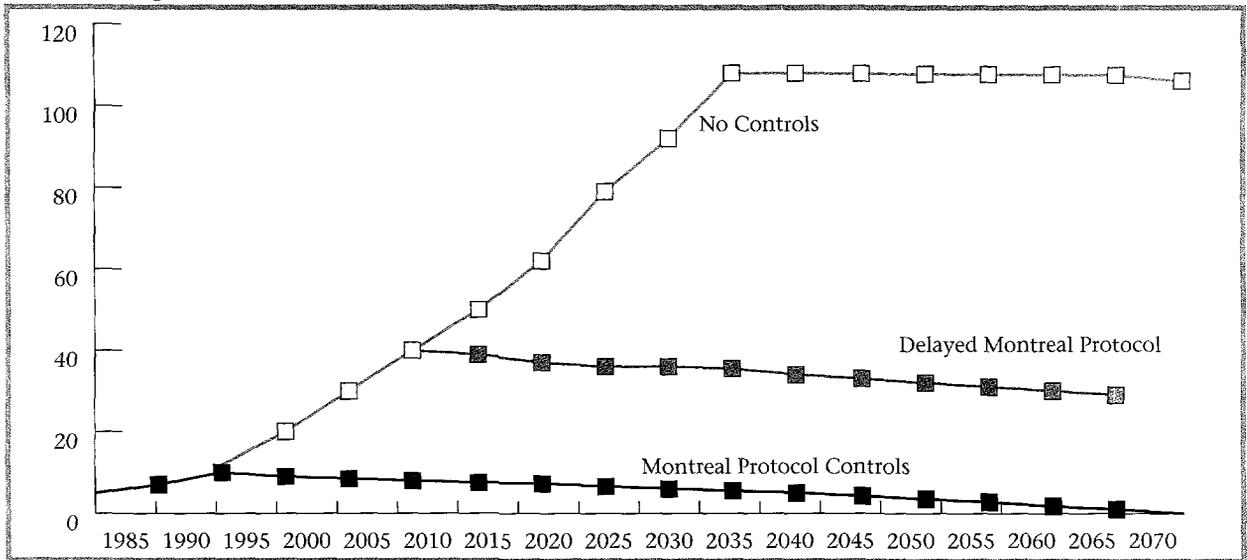
- The decision by international leaders to craft agreements that were not punitive and favored incentives and results-oriented approaches.
- The importance of consistent, predictable government action, appropriate lead times, and the right incentives to foster public-private partnerships and to accommodate different interests and concerns.
- The instrumental role of business leadership in pioneering innovative technical solutions, combined with the realization that companies adjusting first gained competitive and economic advantages.
- The realization that government-led incentive schemes were more effective than direct industry subsidies.
- The value of flexible, market-based solutions in lowering the costs of removing CFCs and finding replacements.
- The participation of all nations in the agreement, though at different levels of responsibility.
- The value of effective multi-stakeholder interaction, despite substantial differences in interests and perspectives.
- The changing role of NGOs, which began with confrontational approaches and evolved towards strategic alliances with industry.
- The importance of precaution and foresight in assessing the



*A surveyor in the Middle East, an African farmer, and a little girl at the beach all have one thing in common – increased risk of skin cancer from increasing amounts of ultraviolet radiation filtering through a degraded ozone layer*



### 7.1 Percentage Increase in UV Radiation Under Alternative Scenarios



Source: Environment Canada 1997

potential long-term impacts of new technologies.

- The need for continued awareness-raising and an appropriate emphasis on enforcement and control measures.

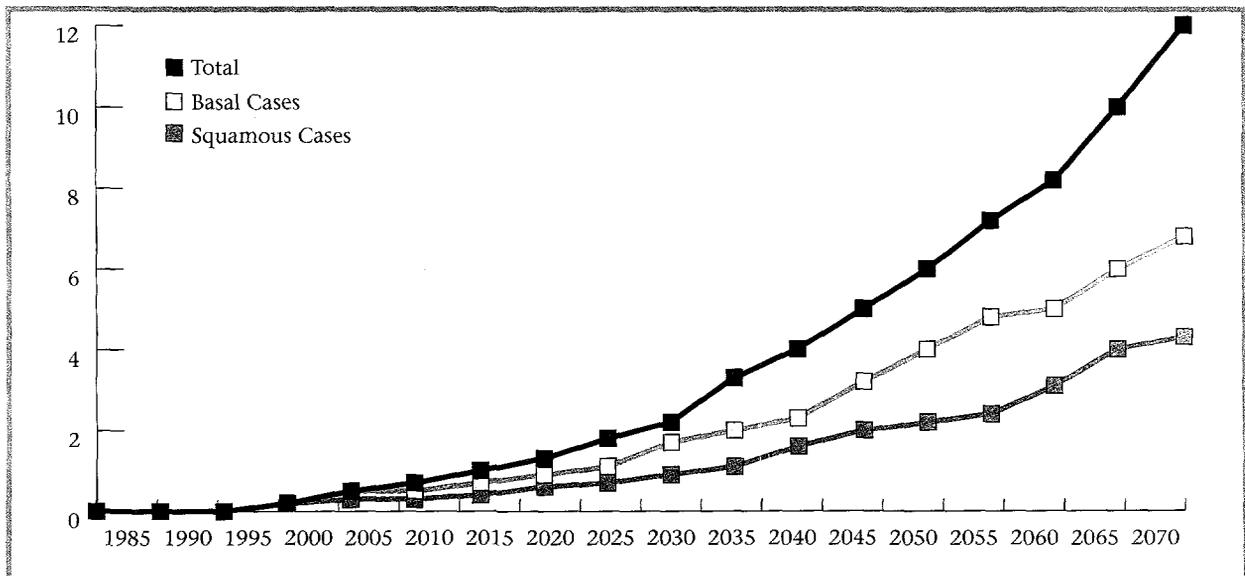
### A Continuing Threat

The ozone-depletion problem is not over. CFCs have relatively long lifetimes – estimated at 50 to 100 years – in the atmosphere. Since the 1960s,

ozone depletion at the higher latitudes has been occurring at the rate of about 5 percent per decade. Depletion should peak around the year 2000, and – assuming full compliance with the Montreal Protocol – the ozone layer should improve thereafter. Full recovery is not expected until about 2050 or later (Fig. 7.1).

The potential health effects of increased UV-radiation are quite serious. A joint UNEP/WHO assess-

### 7.2 Annual Non-Melanoma Skin Cancer Cases Averted Due to Montreal Protocol Controls



Source: Environment Canada 1997

ment concludes that each percent increase in radiation may lead to a 1 percent increase in eye cataracts and a 2 percent increase in skin cancer (Fig. 7.2). In addition, recent medical studies emphasize the adverse impacts of increased UV-B radiation on the human immune system. Immune-system damage is particularly threatening in regions where infectious diseases are common, as they are in most developing countries.

UV-B poses the same dangers to wildlife and domesticated animals as it does to humans. There is conclusive scientific evidence that increased levels of UV-B radiation damage natural habitats. Aquatic ecosystems are particularly vulnerable, including phytoplankton, which is the basic food source for most fish. Recent studies indicate phytoplankton productivity has been inhibited by up to 12 percent under the Antarctic ozone hole. UV-B also impairs the reproductive capacity, growth, and survival rates of many commercial fish species.

UV-B radiation may pose serious threats to world agriculture and forestry. Preliminary research indicates that UV-B may have adverse impacts on important food plants, including inhibition of photosynthesis, damage to DNA, and changes to the form and structure of plants. Experiments with UV-B-sensitive soybeans showed that yields would be reduced by up to 25 percent under conditions of simulated ozone depletion of 25 percent.

In view of these threats, a continuing effort to remove ozone-depleting substances from the global economy is more than justified. A recent Canadian government study, which only measures a few of the likely benefits, concludes that benefits are nearly twice as large as the likely costs of implementation (Fig. 7.3).

## The Early Years

There is now a global consensus about the nature of the ozone depletion problem and the urgent need to phase out CFCs and other ozone-depleting chemicals. But this was not always so; in fact, it

### 7.3 Estimated Benefits and Costs of the Montreal Protocol, 1987-2060

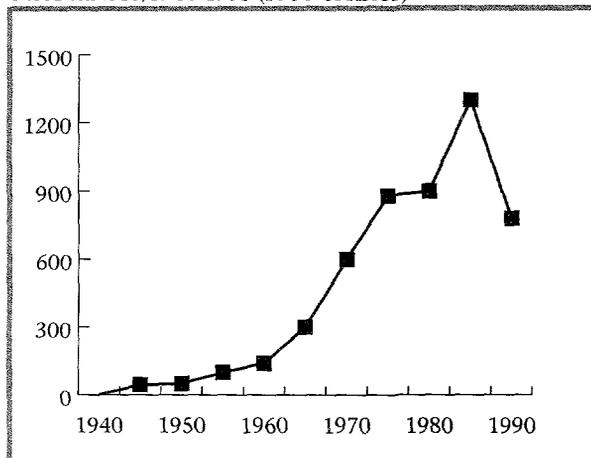
| <b>Health Benefits</b>                    |                                    |
|---|------------------------------------|
| Reduced Cases of Non-Melanoma Skin Cancer | 19,100,000                         |
| Reduced Cases of Melanoma Skin Cancer     | 1,500,000                          |
| Reduced Cases of Cataracts                | 129,100,000                        |
| Reduced Cases of Skin Cancer Fatalities   | 333,500                            |
| <b>Dollar Benefits</b>                    |                                    |
| Reduced Fisheries damage                  | \$238 billion                      |
| Reduced Agricultural damage               | \$191 billion                      |
| Reduced damage to materials               | \$30 billion                       |
| <b>Total dollar benefits</b>              | <b>\$459 billion</b>               |
| <b>Costs</b>                              |                                    |
| Overall costs                             | \$235 billion                      |
| <b>Net benefits</b>                       |                                    |
| Benefits minus costs                      | \$224 billion plus health benefits |

Source: Environment Canada 1997

was not so long ago that satellite data showing evidence of ozone depletion was tossed out as a scientific anomaly and corporate leaders were balking at dealing with the problem.

CFCs, first synthesized in the 1920s, provided the industrial revolution with a highly stable, reliable, nonhazardous group of chemicals. They were invaluable in a variety of industrial processes,

### 7.4 Worldwide Production of Ozone Depleting Substances, 1940-1993 (1000 tonnes)



Source: OzonAction Special Supplement 1995

# The Ozone Protocol: Paradigm for Diplomacy

*Richard E. Benedick*

Just over ten years ago, when only 24 nations signed an ozone treaty in Montreal, none of us could imagine what lay ahead. The protocol was more recently described by the heads of two United Nations organizations as “one of the great international achievements of the century.” Given both the critical danger to all life on Earth posed by thinning of the ozone layer, and the extraordinary extent of global cooperation that was mobilized to save it, few observers would challenge that assessment.

There has since been a virtual explosion of large-scale multilateral negotiations on environmental issues ranging from biological diversity to desertification and establishment of the GEF to the UN Earth Summit. The Montreal Protocol, together with its subsequent implementation history, represented new approaches and tools that made it a paradigm for all subsequent global diplomacy.

With the benefit of hindsight, the ozone treaty has acquired an aura of inevitability; some claim it was “simple” compared to, say, climate change. In reality, as recently as 1985 very few knowledgeable observers believed that any international agreement to control CFCs could be achieved. These were ideal chemicals, constantly finding new uses in thousands of products and industrial processes that made them synonymous with modern standards of living. Technological alternatives were nonexistent, too costly, or unfeasible. Most major countries and most of industry were implacably opposed to controls, as were influential elements within the Reagan Administration. And finally, the argument for controls rested on unproved theories — the potential dangers seemed remote and clear scientific evidence of anthropogenic ozone depletion was lacking.

The central role of scientists in the protocol’s negotiation and subsequent implementation was a distinguishing feature that influenced many succeeding environmental negotiations. Because the science was uncertain, we opted to start with modest initial

targets, but — a crucial point — we also required periodic scientific, technological, economic, and environmental reassessments by independent experts. Thus, unlike traditional treaties, the ozone protocol was deliberately designed to be modified as more knowledge was gained of what was happening. This innovation made the agreement a dynamic, evolving process rather than a static instrument. No one foresaw that greater understanding of threats to the ozone layer would cause the protocol to be revised again and again, expanding the list of controlled chemicals from 8 to over 90, and relentlessly advancing the phaseout schedules.

Further, the Montreal Protocol represented a faith in the market system that proved an important lesson for future environmental agreements. The negotiations in 1987 mandated firm targets and timetables to reduce use and production of chemicals with full knowledge that alternatives were not yet available. However, by providing clear signals and encouraging market instruments, the Protocol was able to unleash the creative energies of industry, resulting in a surge of technology innovation at costs significantly lower than originally anticipated.

An oft-overlooked legacy of the Protocol is the formation of an international network of hundreds of environmental NGOs, linked electronically, that now regularly work together to address environmental problems. While not a single environmental NGO had attended the signing of the 1985 Vienna Convention, a 1989 conference on the ozone layer in London brought together over 90 NGOs and launched their new influence on the global stage.

The Protocol also evolved a sophisticated institutional framework of specialized bodies that effectively responded over the years to a wide range of unanticipated issues, and served as a model for subsequent environmental accords. A unique “spirit of the Protocol” was born — often cited by participants in the treaty’s meetings — that stimulated unprecedented collaboration among governments, international agencies, industries, and citizens organizations.

This spirit also led to innovative forms of North-South cooperation. In contrast to current experience in the climate convention, developing countries

agreed to controls, aided by the first-ever multilateral environmental fund. The ozone fund pioneered equitable voting provisions and the concept of financing "agreed incremental costs" that became models for the GEF and other environmental treaties. Its activities, complemented by cordial North-South cooperation in technology transfer, proved so effective that many developing countries were encouraged to phase out even earlier than required.

In the realm of international relations, there will always be resistance to change and there are always uncertainties – scientific, political, economic, and psychological. The greatest significance of the Montreal Protocol may be its demonstration that the international community of nations is capable of undertaking bold preventative actions in our real world of ambiguity and imperfect knowledge. We all share a responsibility to maintain this vision.

*Ambassador Benedick, author of Ozone Diplomacy: New Directions in Safeguarding the Planet (1998), was chief US negotiator of the Montreal Protocol.*



including aerosol sprays, refrigeration, cleaning of electronic components, and foaming, and by the late 1980s reached a production peak of 1.44 million metric tons (Fig. 7.4).

Intrigued by findings in the early 1970s showing CFC molecules in the atmosphere, Sherwood Rowland and Mario Molina at the University of California began to investigate. They discovered that CFCs could drift up to the stratosphere, decay and, under the influence of intense ultraviolet radiation, release chlorine atoms in the process. In a catalytic chain reaction, the chlorine would aggressively attack ozone molecules, with each chlorine atom triggering the destruction of tens of thousands of ozone compounds.

These findings, soon verified by other scientists, stimulated a global scientific debate and galvanized groups such as the Environmental Defense Fund and the Natural Resources Defense Council. One of the first targets was the use of CFCs in aerosol spray cans. A breakthrough occurred in June 1975, when S.C. Johnson Co. announced its intention to stop using CFCs as a propellant. Other producers eventually followed Johnson's example.

Johnson was one of the first major companies to recognize the strategic advantages of environmental leadership. The decision to ban CFCs from spray cans enhanced the company's reputation. In time, it also became evident that the economics of the move were positive, since the operating costs of alternative propellants turned out to be significantly lower than CFCs. In the U.S. alone, it is estimated that the conversion from CFCs to hydrocarbons in the aerosol sector generated company and consumer cost savings of more than \$1 billion between 1974 and 1983.

U.S. NGOs also deserve some of the credit for winning approval of a ban on CFCs in non-essential aerosol uses in the U.S. as early as 1978. Without them, the ban probably would not have occurred for several more years. Affected industries blocked regulatory action in many European countries for

# Finding Environmentally Safer Technologies

*Thilo Bode*

Greenpeace strives to be the uncompromising voice of the environment. Not surprisingly, this mandate routinely leads it on a collision course with big business and governments. Over the years, Greenpeace has deployed a wide variety of tactics to defend the environment: well documented and broadly disseminated information campaigns; high profile public events; public response campaigns; and strategically executed non-violent direct actions.

Merely identifying and democratizing problems is not sufficient. One of the pivotal challenges facing the world is meeting human needs with technologies that are environmentally sustainable. In recent years, Greenpeace has vigorously engaged in researching, developing, and commercializing technological answers. The organization sees itself as an agent of technological optimism and innovation. It does not engage in inventing new technologies but rather in identifying existing solutions that may have been suppressed or overlooked by industry and governments. From democratizing problems, Greenpeace has thus moved to democratizing solutions.

Paradoxically, dominant corporations tend to play an obstructionist role in the development of new technologies. They prefer to stick to proven profit formulas, remain on existing paths, and avoid risks. These corporations often have less sensitivity to the changing market than consumers. The public tends to support environmentally driven trends, and understands the need for new production technologies and environmentally safer products. Greenpeace, consequently, finds itself in a new style of confrontation with industry – confrontation through solutions.

The most successful solutions campaign to date is the Greenfreeze for domestic refrigeration. Greenfreeze evolved out of an intense conflict between the chemical industry and Greenpeace as to which technologies are most appropriate for

replacing ozone destroying chemicals, especially chlorofluorocarbons (CFCs), in various applications.

Led by such corporate giants as Du Pont, ICI, and Elf Atochem, industry has argued for using products such as hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) as substitutes for CFCs in commercial and domestic refrigeration, air conditioning, foam blowing, and electrical circuit cleansing. However, HCFCs and HFCs are not environmentally sustainable technologies. HCFCs are ozone depleting substances, and are to be phased-out under the terms of the Montreal Protocol. HFCs are potent global warming chemicals and are among the gases whose emissions are to be regulated under the Climate Change Convention and the Kyoto Protocol.

In 1992, Greenpeace financed the development of the Greenfreeze prototype. Greenfreeze uses hydrocarbons as the blowing agent for the insulation foam and as the cooling agent for the refrigerant. Hydrocarbons are completely ozone friendly, and have minimal global warming potential. The use of hydrocarbons in domestic refrigeration is not new. It predates the invention of CFCs in the early 1930s.

After the major refrigerator manufacturers rejected the idea of switching to hydrocarbons, Greenpeace launched a very successful public campaign, gathering tens of thousands of orders from environmentally conscious consumers for the yet-to-be-produced refrigerator. This overwhelming support from the public secured the capital investment needed for the mass production of the Greenfreeze by one company, which subsequently convinced the larger manufacturers of the market appeal of a truly environmentally friendly refrigerator.

Since 1992, Greenfreeze has become the dominant technology in northwest Europe, having taken over nearly all of the German market. There are over 14 million hydrocarbon refrigerators in the world today, and it is estimated that by the year 2000, over 40 million Greenfreeze refrigerators will have been built in Europe alone.

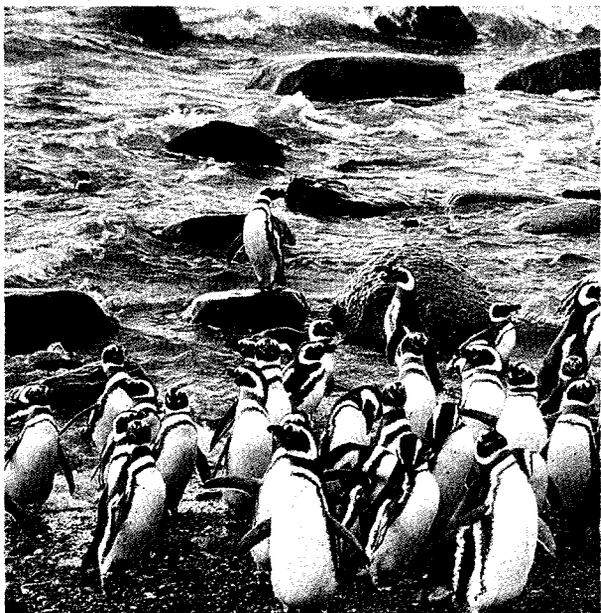
The European Union in December 1996 passed a regulation that would only allow the coveted

“Eco-label” to be displayed on refrigerators that do not use chemicals which harm the ozone layer or contribute significantly to global warming. Refrigerators containing HFCs do not qualify while Greenfreeze does.

There are now over 100 different Greenfreeze models on the market. All of the major European companies – Boost/Simians, Electrolux, Liebherr, Miele, Quelle, Vestfrost, Whirlpool, Bauknecht, and AEG – market Greenfreeze. The technology has also spread to Eastern Europe, Asia, Australia, and Latin America. Most notably, Kelon, the largest company in China, will produce up to 1 million Greenfreeze units in 1997, and plans to expand its production in 1998.

Today Greenpeace is working in collaboration with companies that produce Greenfreeze to expand the market for the technology to all parts of the world, and into other sectors such as commercial refrigeration and automobile air conditioning. This represents an evolutionary development in Greenpeace’s campaigning strategy, designed to address the 21st century challenge of meeting human needs with environmentally sustainable technology.

*Thilo Bode is Executive Director of Greenpeace International, which received UNEP’s Ozone Award at the tenth anniversary meeting of the Montreal Protocol.*



another decade.

As demand weakened in the aerosol sector, CFC manufacturers moved to regain lost profits by developing markets in other sectors, notably high-tech industries such as computers and semiconductors. Eventually this growth more than offset the savings in aerosols, with CFC production reaching more than 1.3 million tons in the mid-1980s. Meanwhile, industry leaders continued to argue about the reliability of the scientific evidence on ozone depletion and resisted further control measures.

Even though the scientific evidence was not yet confirmed, consensus for action was building in the international political community, especially among industrialized nations. The result in 1985 was the Vienna Convention on the Protection of the Ozone Layer, which was adopted by 28 nations. Political leaders deserve credit for having the foresight to reach this agreement even before the issue’s scientific urgency had been confirmed.

Though the Vienna Convention was primarily signed by developed countries and did not contain any control measures, it was nevertheless clearly a watershed event. It established the first international legal framework for action to protect the ozone layer.

The convention was also significant in that it was one of the few times that diplomats had listened to the advice of scientists about a threat facing the planet. In the process, both the scientific community and environmental advocacy groups gained new attention and influence. Political leaders, in turn, were instrumental in mediating conflicts and building consensus among a great diversity of public and private stakeholders – experience that has proved valuable in later negotiations over issues such as climate change and biodiversity.

The merits of the science shifted dramatically in the mid-1980s. A key turning point was a May 1985 article in *Nature*, in which researchers from

## Calculating Costs and Benefits

A recent Canadian government study concludes that overall costs of the Protocol through the year 2060 will be about \$235 billion, compared to likely benefits of \$459 billion due to reduced damages in fisheries, agriculture, and man-made materials. Not translated into financial equivalents are estimated health benefits of more than 20 million avoided cases of skin cancer, approximately 130 million avoided cases of fatal cataracts, and up to 333,500 fewer deaths due to skin cancer (Environment Canada, 1997).

The macroeconomic benefits also have been substantial. In the aerosol sector in the U.S., it is estimated that the early conversion from CFCs to hydrocarbons generated company and consumer cost savings of more than \$1 billion between 1974 and 1983. Furthermore, the accelerated turnover of industry equipment has created thousands of new jobs in the industrial engineering sector.

the British Antarctic Survey described a massive seasonal ozone hole over Halley Bay in Antarctica. With this alarming new evidence of rapidly declining ozone concentrations over Antarctica, the debate reached a new level of urgency.

## The Montreal Protocol

Just two years after the Vienna convention, international negotiators met again in Montreal to discuss a stronger international commitment on CFCs and ozone protection.

Adopted in 1987, the Montreal Protocol initially required developed countries to cut CFC emissions by 50 percent by the year 2000. A 10-year grace period was added for developing countries. When monitoring results in the early 1990s indicated that even northern and middle latitudes might suf-

fer a 5 percent decline in seasonal ozone concentrations per decade, negotiators quickly returned to the bargaining table – in London in 1990, in Copenhagen in 1992, in Vienna in 1995, and again in Montreal in 1997 – to toughen the agreement. More than 90 different ozone-depleting substances are now covered by the agreement, including hydrochlorofluorocarbons and methyl bromide. The Montreal Protocol was the first international treaty to lay out different obligations for developed and developing nations. This was a major breakthrough in international law, since it recognized the differing circumstances facing developing countries.

Another important feature of the Protocol was the creation of permanent advisory panels on scientific and technical issues. These panels have proven to be an effective way to ensure continuing communication among scientists, government officials, and private stakeholders. Their leadership in keeping negotiators up-to-date on the latest scientific and technical developments has been an important factor in revising the protocol in response to new knowledge about the problem and options to solve it.

The amended Protocol has already led to a major success – the complete phaseout of about 1 million metric tons of CFCs in industrialized countries by 1996 (all but about 10,000 tons required for essential uses). Developing countries are expected to follow by 2010, beginning with a freeze on consumption of ozone-depleting substances by 1999 (Fig. 7.5).

The effort to implement the Protocol has been a remarkable success, thanks in part to the Protocol's clear goals and deadlines, along with industry leadership, voluntary agreements, and the advocacy and partnership roles of consumer and environmental groups.

## Sources of Success

One of the advantages of the Montreal Protocol is

its emphasis on country flexibility. Rather than dictating what has to be done by the Parties to achieve agreed phaseout measures, it simply requires verification of compliance with the agreed control schedules and measures. This leaves it up to each individual country and regional group to determine the most effective ways to meet the targets.

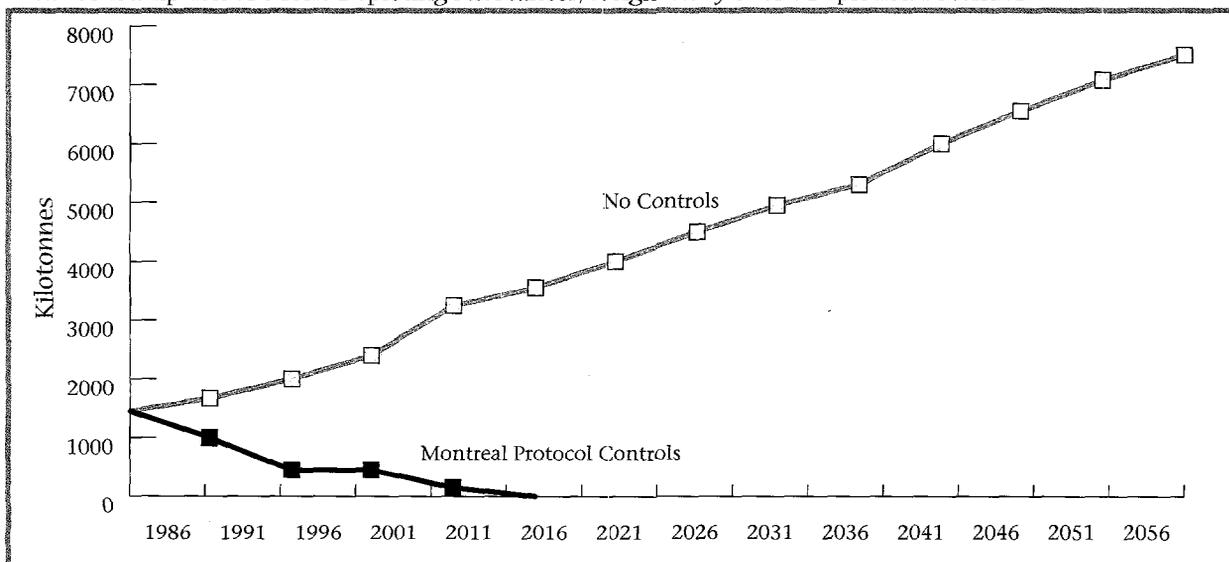
Developed countries are using a wide array of regulatory tools to meet the agreement's goals, including: traditional command and control measures such as bans; specific limitations; and quotas and standards combined with penalty systems. These approaches have been widely used in Europe and in countries with economies in transition. The U.S. has tried several innovative approaches, such as excise taxes, charges, and tradable permits.

National experience in applying these economic and other regulatory instruments varies greatly, and there seems to be no standard solution. The most important prerequisites for success seem to be market orientation and flexible adaptation to specific circumstances in each sector and country. If properly designed and monitored, tradable permits have the potential to balance economic and environmental interests and to provide incentives for least-cost adaptation at the same time.

Comprehensive monitoring and enforcement regimes are necessary under all circumstances. The cost for adequate control tends to be similar no matter which regulatory tools are being applied. Combined quota, permit, and trade systems are efficient ways to provide incentives for early adaptation and the sale of allowances. If not carefully designed, however, trading systems may prove to be costly. If the government must repurchase allowances it has auctioned before to comply with strengthened emission reduction targets, this may lead to significant additional government expenses. If quotas and permissions are dispensed at no charge, they may lead to considerable market distortions and cross industry subsidization. Enterprises with allegedly high consumption needs may get a quota higher than is really necessary, which would most probably be resold. This would unduly penalize companies that received a lower quota.

The European Union eventually settled on the use of a traditional quota system without trading options to set the overall framework for the phase-out of ozone-depleting substances in the region. This approach has been successful. In many cases, the quotas have been superseded by formal bans applicable to all member countries that are actual-

7.5 Consumption of Ozone-Depleting Substances, Weighted by Ozone Depletion Potential



Source: Environment Canada 1997

# Model of International Cooperation

Qu Geping

Increasingly rising public environmental awareness has helped to promote the most successful example of international environmental cooperation in the world - the protection of the ozone layer. Humanity is making steady progress in phasing out ozone depletion substances and China has made its contribution to this endeavor.

The success to date is due to the following factors:

- The Montreal Protocol on Substances that Deplete the Ozone Layer and its Amendments reflect the principle of common but differentiated responsibility, confirmed at the United Nations Conference on Environment and Development in Rio, and this laid a solid base for setting up clear and binding targets.
- Through the Multilateral Fund of the Montreal Protocol, developed countries provide financial resources and transfer technologies to developing countries, thus facilitating the phase-out of ozone depleting substances by developing countries.
- Parties to the Protocol established national targets and action plans, and used a combined approach of policy, administrative control, and economic incentives to reach reduction targets.
- Full consultation and close cooperation between governmental agencies and the private sector led to consensus building and concerted actions among partners in the establishment and implementation of national reduction objectives and action plans.
- Public awareness and dissemination of the Montreal Protocol undertaken by governmental agencies and social groups promote the involvement of producers and consumers in national efforts toward ozone layer protection.
- Industry has incentives to research, develop, and produce substitutes for ozone depleting substances – in part because of limitations on them in the market.

- In addition, the effective work of relevant international organizations should also be fully recognized.

In spite of these efforts, ozone depletion is far from resolved. To successfully protect the ozone layer, the international community should continue to adhere to the principle of international cooperation and make further efforts to ensure, inter alia, the smooth operation of the Multilateral Fund, further promotion of public participation, and the use of markets.

Collective efforts made in this area have set a good example for international environmental cooperation. The world community should show the same social vision, political courage, and cooperative spirit in other areas of the global environment, such as climate change and biological diversity.

*Qu Geping is Chairman of the Committee on Environmental Protection and Resources Conservation of China's National People's Congress.*



ly stricter than the Protocol requirements. For example, HCFCs are already banned for many industrial uses, including residential refrigerators and mobile air conditioning, even though the Protocol permits these substances to be used for another three decades. HCFCs will be phased out of commercial refrigeration by the year 2000 and eliminated in all other uses by 2015 – still 15 years ahead of the current schedule.

Voluntary commitments on the part of industry associations are another important factor contributing to the success of the Protocol, particularly in Europe. For example, the German industry association voluntarily phased out all ozone-depleting substances in the foaming sector by the end of 1993, which was two years ahead of schedule.

## New Partnerships

One of the remarkable aspects of the implementation effort has been the changing role of environmental advocacy groups. These groups traditionally have mounted strong media campaigns against industry. In recent years, many of these groups have taken a new approach, forming strategic alliances with industry.

Companies are now working with environmental groups to consider environmental factors in the development of their products and services. In many countries, industry-NGO partnerships are a standard marketing tool. NGO eco-labels can be found on products throughout Europe.

These partnerships often involve the development of new technologies and alternative or transitional substances. In early 1992, Greenpeace entered into an alliance with FORON – a small, entrepreneurial refrigerator company in Germany – to promote alternative refrigeration technologies that would phase out ozone-depleting substances and reduce GHG emissions at the same time. New refrigerators were developed within six months and were available to the European market within a year. (See essay, p.140).

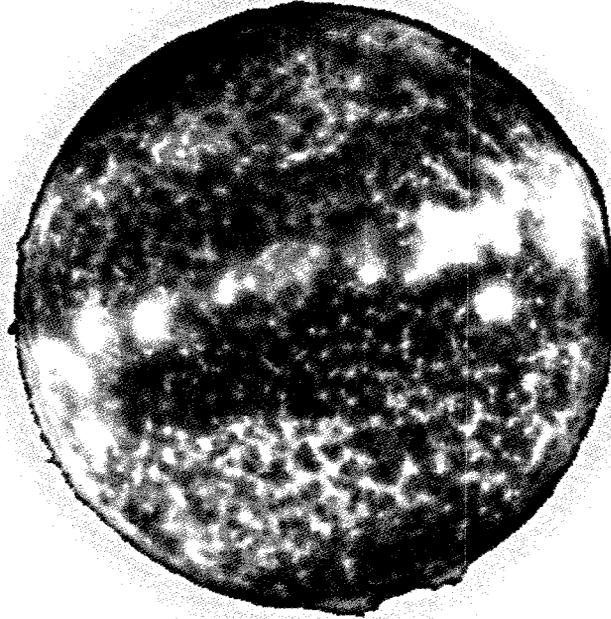
To speed the process, Greenpeace provided a contingent loan to the company that would be paid back when the new technology had become economically viable. In part because of its interest in FORON's repayment of the loan, Greenpeace aggressively promoted the new technology in Europe. Eventually, even the German government and the European Commission honored the effort.

The "Greenfreeze" received an official German eco-label in 1993 and UNEP's Ozone Award in 1997. This award boosted consumer awareness, which propelled the new refrigerator to a remarkable marketing success in Central Europe. Due to strong consumer demand, all other leading European refrigerator makers were quickly forced to offer models using the new technology. The refrigerator market in most of Central Europe is now dominated by the new technology, and the same standards are a prerequisite for the European Union eco-label.

For its role in this effort, Greenpeace was the first environmental advocacy group to receive a major European consumer marketing award for their innovativeness in promoting environmentally sound consumer products.

Inspired by this unexpected success, Greenpeace and other NGOs have begun to promote environmentally sound technologies in developing countries. Some of these efforts also have been surprisingly successful. In November 1995, at a meeting in Vienna of the members of the Montreal Protocol, a leading Chinese refrigerator maker displayed a model based on the new green technology.

The new technology was developed in part with financing from the Montreal Protocol's Multilateral Fund. Environmental groups also played an important role, offering technical advice on options to phase out CFCs to several major Chinese refrigerator manufacturers. Since then, two other Chinese companies have introduced the green refrigerator technology without any international financing. These companies are responding



to growing international demand and to the opportunity to seize a competitive advantage in the Chinese market. In order to gain market share in the European Union, a leading Turkish refrigerator company (Arcelik) also has decided to develop a refrigerator that meets the standards for the European eco-seal.

## The Multilateral Fund

Whether the deadlines for developing countries can be met depends to a large extent on the effectiveness of the Protocol's financial mechanism to support the CFC phaseout in developing countries.

Established in 1990, the Multilateral Fund already has pledged of more than \$1 billion for the phase-out of ozone-depleting substances in developing countries. About \$700 million has been allocated to date.

The fund is designed to pay for the agreed incremental cost borne by developing countries in phasing out ozone-depleting substances. Both the incremental cost approach and the Fund's governing structure, which includes equal numbers of developed and developing country parties, constitute pioneering approaches that have set precedents for subsequent global environmental agreements, including the climate change and biodiversity conventions.

The Multilateral Fund has already financed the development of nearly 90 country-wide ODS phaseout programs. As of January 1998, projects financed by the Fund would phase out more than 90,000 tons of ozone-depleting substances, which represents over one-third of reported consumption in developing countries.

The Fund has actively evolved and innovated over

the years. A few trends and accomplishments are particularly noteworthy, including:

- The establishment of cost-effectiveness thresholds, which award financing to the most cost-effective projects first and defer financing for less-efficient projects.
- The review of regulatory or other impediments that may be affecting implementation of projects in countries proposing new activities, where previously approved projects had no disbursements for a long period of time.
- A gradual shift from company to sector-wide approaches.
- Continuous encouragement for the development of innovative financing solutions, e.g. concessional loans and contingent grants (although these have not yet been realized).

In the early years of the Montreal Protocol, there was a general agreement that direct subsidies to industries would be the best way to expedite CFC phase-out in developing countries. More recently, there has been an important shift from single enterprise to group or sector-wide approaches, and the development of cost-effectiveness thresholds for direct industry subsidy programs.

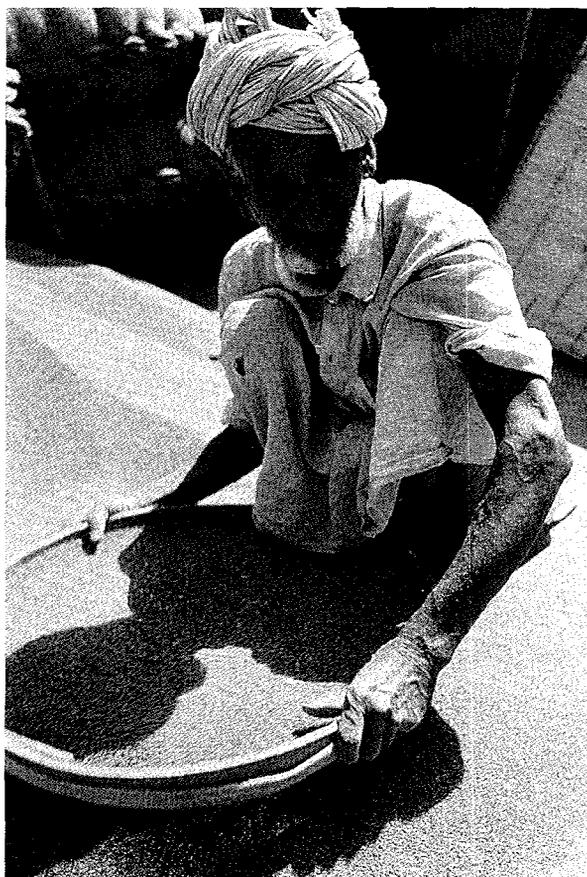
More importantly, implementing agencies increasingly are forming strategic partnerships with recipient governments. These new partnerships promise to substantially improve the cost-effectiveness of Multilateral Fund programs. They may multiply the impact of Multilateral Fund resources by reducing CFC use in whole markets, rather than just one enterprise.

Perhaps the most significant effort to encourage the consideration of innovative economic instruments and other market based regulatory tools is a project jointly developed by the World Bank and Chinese officials to phase out halons in China. It gives the national government, together with the implementing agency, flexibility to find the most effective ways to eliminate these compounds. This phased Multilateral Fund grant is linked to the regu-

lar verification of sector-wide phase out results, rather than to commitments by individual enterprises.

The approach provides incentives to the government to look for the most efficient phaseout instruments and incentive-based regulatory approaches. The government is fully accountable for reaching the agreed milestones, and will periodically receive agreed installments of grant funds, provided that compliance can be verified by an independent auditor. This sector-wide approach could reduce compliance costs to less than \$1 per kilogram of halons, compared to about \$3 per kilogram for direct subsidies to enterprises.

Both donors and recipients will follow this program with great interest, since it awards governments incrementally for their efforts to steer markets and to keep incremental costs low. It also puts governments in the center of the action, whereas funds flowing directly to enterprises tend to reduce the government's role.



# Atmospheric Chemistry & the Tropics

Paul Crutzen

The influence of human activities is clearly discernible in rising concentrations of several radiatively and chemically important gases and particles. This is due to direct increases in primary emissions of carbon monoxide, methane, nitrogen oxides, and CFCs and indirectly through chemical transformations which affect especially the concentrations of ozone and particulate matter.

The precipitous chemical loss of ozone in the lower stratosphere in the late winter/spring period over Antarctica (the so-called "ozone hole") has been the most dramatic example of a human-caused change in the global atmospheric chemistry system. The loss of ozone has a substantial effect on the penetration of biologically harmful, solar ultraviolet radiation to Earth's surface.

Ozone in the troposphere (lower atmosphere) also has been strongly affected by human activities. Increased industrial and agricultural emissions of nitrogen oxides, carbon monoxide, and methane leads to growing ozone concentrations, which have been observed at a number of European stations with long-standing measurement records. Because ozone is a greenhouse gas, ozone will cause health effects and climate warming.

Tropospheric ozone is of the greatest importance in atmospheric chemistry because of its role in the production of OH radicals via a set of chemical reactions. Ultraviolet radiation with wavelengths shorter than about 325 nm plays a major role. Despite very low concentrations on the order of an average of 4 OH radicals per  $10^{14}$  air molecules, its great reactivity makes OH the main oxidizing agent in the troposphere.

As a consequence, the average removal times of almost all natural and anthropogenic trace gases in the atmosphere are determined by their reactivity towards OH, the "detergent" of the atmosphere. Because of high levels of UV-radiation and water vapor, the concentrations of OH strongly maximize in the tropics. Due to changes in the levels of

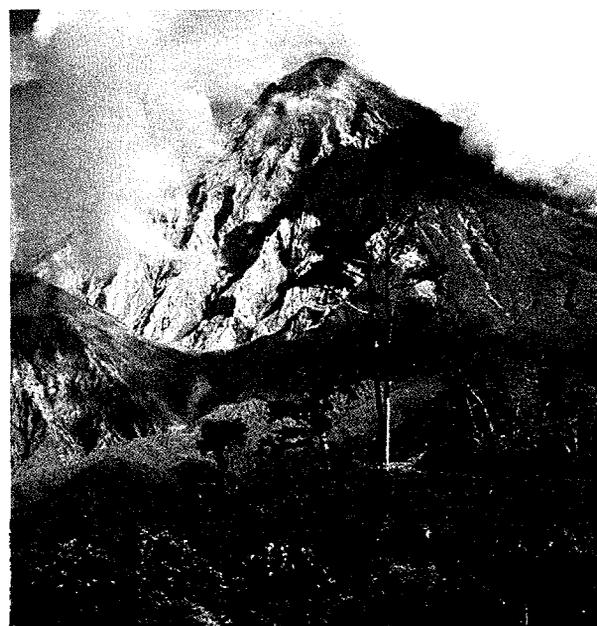
UV-radiation and increased anthropogenic emissions of nitrogen oxides, methane, and carbon monoxide (e.g. by biomass burning) substantial changes in the future levels of ozone and OH concentrations are expected.

With populations growing in the developing world, maximum changes in the chemistry of the atmosphere no doubt can be expected in the tropics and subtropics. This is the region of the atmosphere about which we have very limited knowledge.

It is therefore particularly important that research efforts be increasingly devoted to atmospheric chemistry research in the tropics and subtropics. We must build up a strong research base. Although such a goal does not produce immediate gains, over the longer term the active involvement of talented scientists from developing countries in atmospheric chemistry and climate research is of the utmost importance.

I am certain that, as has been the case in the industrial world, such research can attract and support some of the most talented and ambitious students. I call upon the GEF to play a much more active role towards this end.

*Paul Crutzen, Nobel Laureate in 1995 for his work on ozone, is professor of atmospheric chemistry at the Max Planck Institute in Mainz, Germany.*



Government ownership of phaseout programs is an important prerequisite for the development of effective economic and market-based regulatory instruments. Getting governments involved and giving them appropriate incentives can help unleash the power of these instruments.

## Compliance: The Key Issue

The Protocol is the first international environmental treaty with a formal procedure requiring annual verification of compliance. An Implementation Committee was established to review government submissions regarding compliance. Nonpunitive procedures also have been adopted to deal with cases of noncompliance.

Many countries, including particularly those with economies in transition, have benefited greatly from the flexibility of these provisions. Decisions made under the noncompliance procedure reflect the specific circumstances of ODS phase out in each region and provide incentives for the early solution of identified problems, rather than punishing countries experiencing temporary difficulties due to economic problems.

Surprisingly, until recently there was no public debate about the need to control compliance effectively. Data submitted to the Implementation Committee seemed to be readily accepted as sufficient evidence verifying progress in implementing the Protocol. The Protocol does not provide for independent verification of this data.

Again, NGOs have filled an obvious gap here. For example, organizations like the Environmental Investigation Agency (EIA) and Friends of the Earth have taken the lead in investigating the illegal market for CFCs. At the Costa Rica meeting of the Parties in December 1996, the Environmental Investigation Agency issued its first report about rapidly increasing flows of illegally traded CFCs to industrialized countries. The most recent 1997 EIA report estimates that at least 10,000 tons of smuggled CFCs flooded the U.S. market between 1994

and 1996. Steep excise taxes imposed on CFCs by the U.S. government have provided a considerable incentive for the illegal movement of CFCs.

Illegal trade estimates for the European Union vary greatly. However, it seems certain that CFC smuggling is also increasing there. Several spectacular cases discovered in Europe in the summer of 1997 have led to a growing public awareness and immediate responses on the part of concerned citizens and NGOs.

Perhaps partly in response to this problem, the European Union in September 1997 took the lead in advocating strengthened trade control provisions for the Protocol. One of the important results of the meeting was an agreement on more effective enforcement measures through international licensing schemes.

## Summing Up

What have we learned from experience in dealing with the ozone-depletion problem?

Certainly one lesson is that establishing as scientific fact the reality of an immediate threat to human health and the global environment can lead to targeted and effective action. Once the potential harm is widely acknowledged, affected stakeholders are – sometimes grudgingly – willing to admit that action is necessary even if it may entail additional costs.

Though we now tend to take for granted the multistakeholder nature of the process, it is important to note that the involvement of all affected stakeholders – despite substantial differences in interests and perspectives – has been absolutely crucial to the success of the effort. In particular, the continued participation of all nations remains vital.

Another lesson is the key role played by advocacy groups and other NGOs in influencing public, private, and governmental opinion and urging policymakers to take action to deal with the problem.

# Unintended Consequences

Mario Molina

Our standard of living has increased enormously in this century, particularly in the industrial countries. And yet, an unintended consequence of this progress has been the degradation of the environment. We have come to recognize that the impact of human activity on the environment has reached global proportions.

Perhaps the best understood global environmental issue is the one involving chlorofluorocarbons (CFCs) and the ozone layer. CFCs are extremely stable chemical compounds developed as replacements for toxic refrigerants such as ammonia and sulfur dioxide. Ironically, it is their very stability that allows them to reach the stratosphere, where they decompose, depleting the ozone layer that protects life on earth from harmful ultraviolet radiation from the sun. Released predominantly in the Northern Hemisphere, the most striking effects of CFCs occur over the South Pole – as far as possible from their original sources.

There are two important lessons to be learned from the CFC issue: first, humans are clearly capable of damaging the environment on a planetary scale; and second, humans are also capable of solving global-scale problems. The CFC problem is to a large extent under control as a result of an international agreement, the Montreal Protocol on Substances that Deplete the Ozone Layer, coordinated by the United Nations Environment Programme.

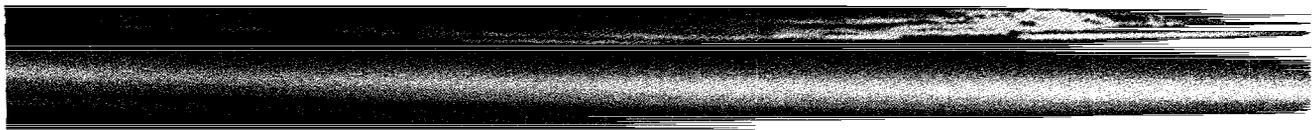
The international scientific community played a crucial role in the creation of this agreement.

Scientists were able to make a strong case that stratospheric ozone has been decreasing in recent years, particularly at high latitudes, and this decrease is a direct consequence of the release of industrial compounds, mainly CFCs. It is also clear that ozone depletion causes ultraviolet radiation levels to increase at the Earth's surface; however, much remains to be learned about the overall impact of these increased levels on the biosphere.

In spite of this incomplete knowledge, the decision to call for a world-wide CFC ban is well justified. First of all, the ozone layer is a very large natural system that provides an essential life support function – the amount of solar energy absorbed by atmospheric ozone is more than an order of magnitude larger than the total amount of energy used by humankind. Furthermore, scientific research has shown several examples of ecological systems that are very sensitive to ultraviolet radiation, such as certain fish larvae, amphibian eggs, soy bean crops, etc., and there are effects on humans themselves, such as skin cancer and eye cataracts.

The formulation of the Montreal Protocol required the participation not only of scientists, but also of industry, policy makers, and environmentalists. It sets a very important precedent that demonstrates how these different sectors of society can work together and be very productive. It emphasizes the fact that global problems cannot be solved without the active participation of all the countries of the world—developing and developed.

Another important precedent established by the Protocol is the inclusion of procedures for periodic revisions of its terms based on evolving scientific understanding, technological capability, and eco-



conomic considerations. The international agreement was amended in 1990 in London, and then in 1992 in Copenhagen, leading to a complete ban on the manufacture of CFCs by industrialized countries by the end of 1995. Today, the world community still enjoys the benefits of refrigeration, air conditioning, plastic foams, aerosol spray cans, etc., but it is with new, CFC-free technologies.

My own experience with the CFC-ozone depletion issue prompts me to believe that we can meet the challenge presented by global environmental issues in the 21st century—including global warming, increased tropospheric ozone, loss of biodiversity, deforestation, and land degradation. I am hopeful that the world community will again rely on scientific understanding to provide the foundation for decisive and responsible action. There have been major changes in the public's attitudes concerning environmental problems, when it is understood that the health of the entire planet is at stake.

Given the motivation, the world community has the ability to make substantial changes and adopt new ways of functioning, while at the same time enhancing the quality of life in all nations. It is also clear that we have a long way to go; the quality of life of future generations will be based to a large extent on our ability to deal intelligently with the emerging global environmental challenges.

*Mario Molina shared a Nobel Prize in 1995 for his work on stratospheric ozone depletion and is currently a professor at the Massachusetts Institute of Technology.*

While continuing in their roles as advocates, many of these groups also have creatively devised new roles, both as partners with industry in supporting and promoting new technologies and as allies with governments in uncovering illegal trade. Industries, in turn, have increasingly viewed the phaseout as a new market opportunity and a way to reduce long-term economic costs rather than a burden.

A third lesson is that the flexible, nonpunitive, incentives-oriented approach taken by the Protocol has promoted economic and technological progress and created new markets for environmentally sound products. In general, the phaseout experience has shown that early cost estimates were far higher than actual costs. In 1988, average phaseout costs in the U.S. to remove the first 50 percent of CFCs were estimated at \$3.55 per kilogram. Four years later, the estimate to remove all CFCs had already been reduced to \$2.20 per kilogram.

A fourth lesson is that consistent, predictable government action and appropriate lead-times helped build consensus despite fundamental differences in economic, political, and social interests. The ozone case has proven that the right incentives at the right time can foster private-public partnerships that accommodate different interests and concerns. Individual and corporate leaders, sound information, effective outreach and means of communication, as well as willingness to cooperate have bridged political and economic differences in favor of the protection of the global environment.

Despite this progress, it is important to maintain the momentum to implement the Montreal Protocol. Recent findings of increasing illegal trade of ozone-depleting substances underline the need for continued awareness raising, caution and appropriate emphasis on enforcement.

In addition, since ozone-depleting substances also are among the gases that contribute to climate change, there are numerous opportunities to achieve synergies

# The Illegal Trade in CFCs and Halons

Allan Thornton

Full compliance remains a distant and elusive goal for the Parties to the Montreal Protocol due to the ease with which unscrupulous individuals and companies have exploited several major loopholes.

The Environmental Investigation Agency, a non-governmental environmental group with offices in London, England, and Washington, DC, has confirmed the existence of a highly organized and extensive illegal international trade in CFCs and halons.

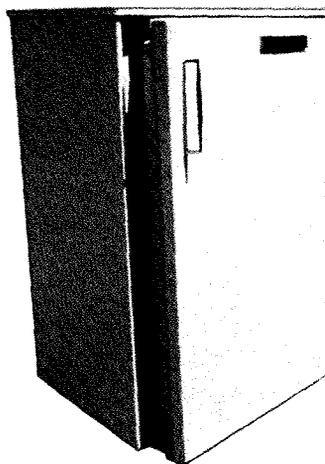
Countries with economies in transition such as Russia and other nations that were part of the former Soviet Union were given exemptions to allow a longer than expected phase out time for their production of CFCs and halons.

The political and economic turbulence in these countries provided a significant incentive for the illicit export and sale of ozone depleting chemicals into countries which, under the terms of the Montreal Protocol, had ceased to produce CFCs and halons for sale on their domestic markets.

Russian CFCs began to flood western markets in 1994. Industry representatives in the United States and in Europe began to press their governments to take action against the illicit trade. Industries which had invested heavily in alternatives to CFCs were concerned they would be undercut by the large scale import of illicit CFCs.

The United States promptly responded by setting up a federal task force, comprised of officials from the U.S. Justice Department and its environmental crimes unit, the Internal Revenue Service, the Customs Service, the Environmental Protection Agency, and the Federal Bureau of Investigation. This task force proved an effective counter to large scale smuggling of CFCs into the U.S.

European authorities were slower to respond. National governments of the European Union countries were skeptical that illegal CFC and halon trade was a serious problem. Two EU working meetings in 1995 and 1996 failed to produce a consensus on the nature and extent of the problem, and no action program was produced to respond to this growing threat, despite strong statements from politicians such as John Gummer, then Secretary for the Environment of the UK.



EIA discovered that Montreal Protocol provisions for "inward processing relief" (IPR) – whereby industrialized countries could import CFCs from developing countries for repackaging into smaller containers and export to developing countries – provided a major loophole, which allowed European companies to deflect legitimate IPR shipments illicitly onto the European market. EIA found CFC containers repackaged in the UK on sale in Spain.

An increasing number of leads were passed to EIA – by industry representatives and fellow environmentalists. One German company – Taifun – was pointed to by numerous contacts across Europe for offering cheap CFCs and halons in containers configured for the Chinese, not the European market. The German customs authorities, in co-operation with the EU Serious Fraud Office and the Dutch and Belgian authorities, cracked down on Taifun for selling hundreds of tons of illegally imported CFCs and halons to companies across Europe and the United States.

Taifun's buyers' list reads like a who's who in the chemical industry, with many of the biggest companies in Europe and America pleading ignorance of the origin of the illicit materials.

Taifun's activities are paralleled by numerous fly-by-night companies offering cut price CFCs and halons from Russia, China, and India.

EIA set up a dummy company and communicated with numerous suspicious firms. Within days, it was flooded with offers of illicit CFCs and halons from companies around the world. Chinese middlemen were particularly aggressive in marketing their products and these efforts continue in Europe and North America at the time this article was written.

The solution lies in several measures.

- The first is for industrialized countries to prohibit the sale of CFCs and halons to simplify enforcement.
- Second, increased enforcement measures – with formal and coordinated international co-operation between the US and European authorities and non-governmental groups like the Environmental Investigation Agency, where appropriate – are needed to intercept and tackle this growing illegal trade.
- Finally, additional bilateral or multilateral co-operation can be used to focus CFC and halon phaseout programs in developing countries still producing these ozone depleting chemicals to ensure their national authorities are aware of illicit exports.

*Allan Thornton directs the Environmental Investigation Agency in London and Washington, DC.*



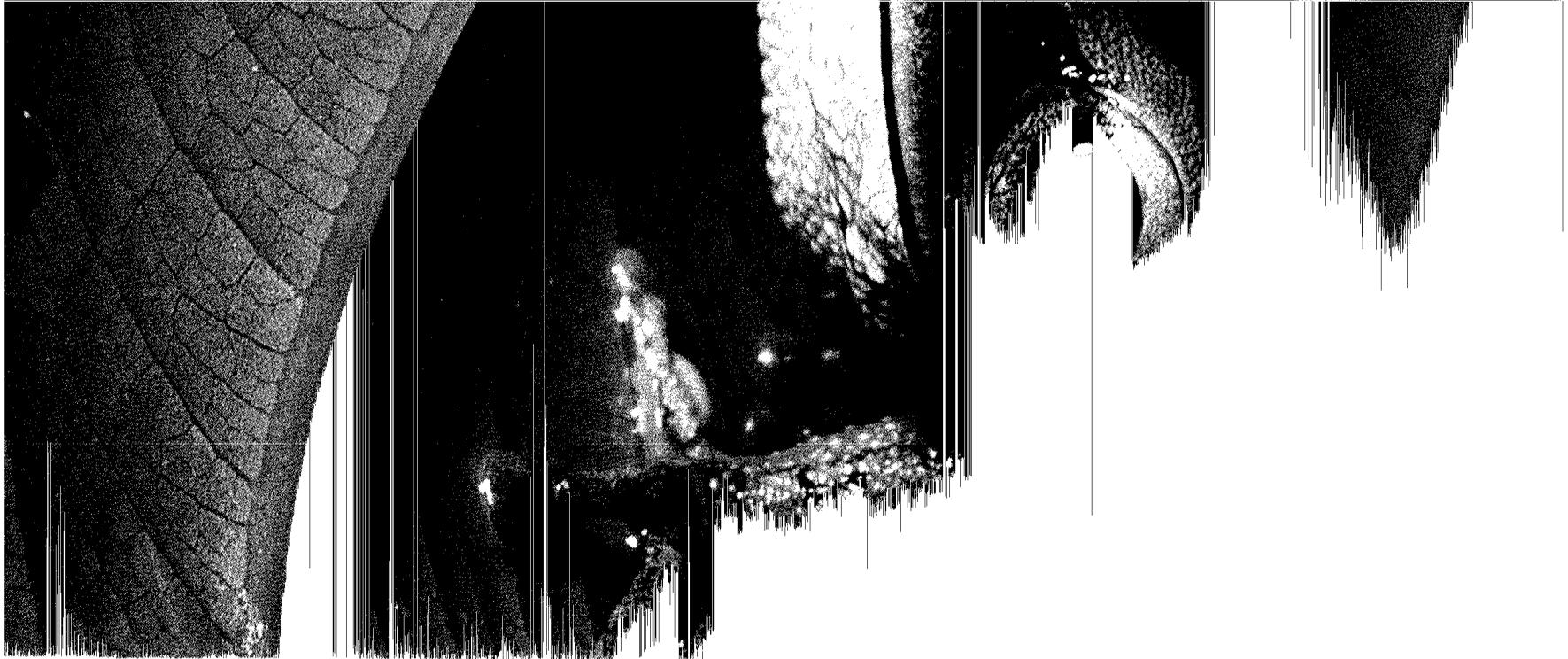
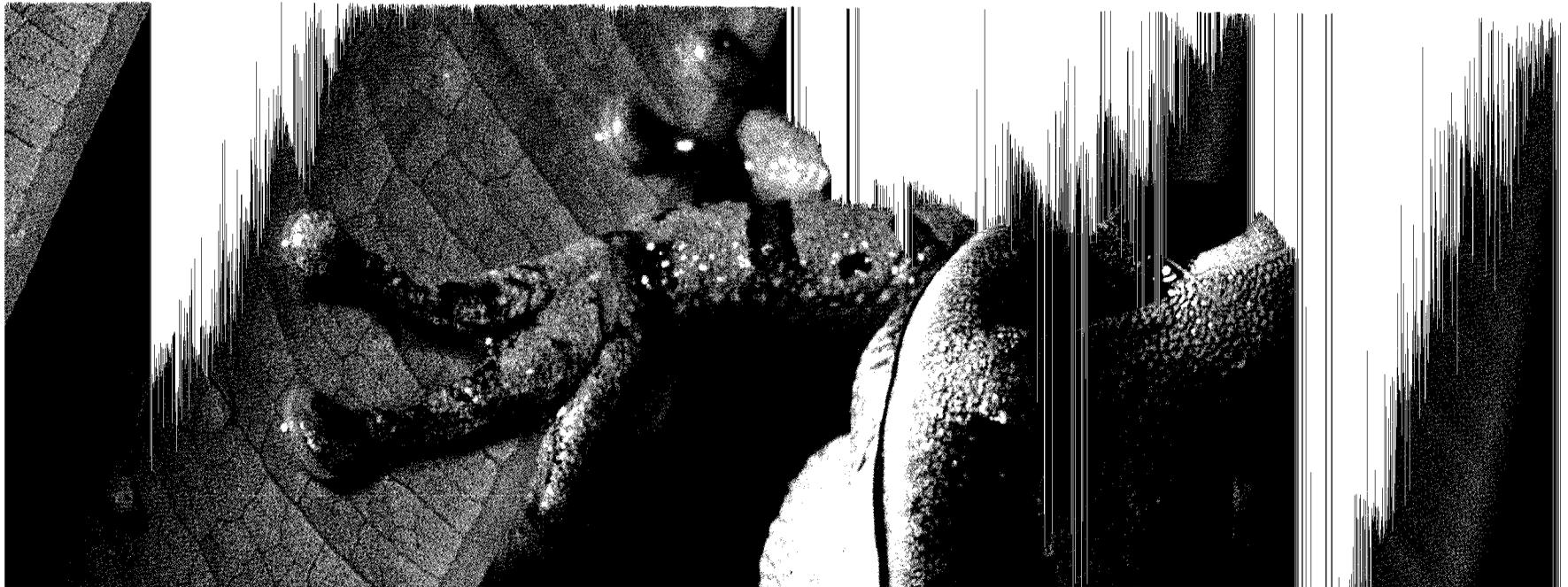
with the international effort to reduce greenhouse gases. For example, the Kyoto Protocol to the Framework Convention on Climate Change requires Parties to control hydrofluorocarbons, a group of CFC substitutes with extremely high global warming potential that are not covered by the Montreal Protocol. This will provide a significant incentive for enterprises to skip transitional solutions in phasing out CFCs.

The ozone case has proven that technological change towards environmentally sound solutions can be facilitated effectively with consumer awareness and incentive-oriented regulatory instruments. But this is only true if market distortions can be avoided. A level playing field at the national, regional, and global levels is a prerequisite for market success.

Although the phaseout of ozone-depleting substances looks like a smooth transition today, it is important to remember that only a few years ago most industries argued that CFC alternatives would be either unaffordable, unavailable, or much more hazardous. However, when corporations accepted the need for change, the power of market mechanisms led to quick and effective industry responses. Technological innovation, spurred by competition among entrepreneurs seeking new market niches, has often led to alternative solutions that turned out to be economically more attractive than the CFC baseline technology.

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# Epilogue: Getting There From Here

Albert Einstein was deep in thought when the train conductor asked for his ticket. After a lengthy search of his pockets, the Nobel laureate jumped up and pulled his suitcase down from the rack. Recognizing his passenger, the conductor said: "Don't worry, Professor, I'm sure Princeton University will pay for another ticket." Einstein replied: "Young man, it's not the price of the ticket I am worried about. I need to know where I'm going."

The preceding seven chapters have been about booking passage to a different global future, while we still can. The journey has already begun in many respects, but reaching the destination requires that everyone be on board.

As our book has tried to demonstrate, there is clear reason for optimism. During the last quarter century, we have reached a common global understanding of the fundamental threats to Earth's ecological balance. During this same period, the world community has also reached consensus on many of the solutions. Witness the Montreal Protocol on Ozone Depleting Substances, Agenda 21, the conventions on biological diversity and climate change, the Kyoto Protocol, and the creation and restructuring of the Global Environment Facility (GEF).



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The ongoing challenge is to move from the blueprint to the building stage. We must all do our part to breathe life into these commitments, not just nationally and internationally, but also in the places we live and work.

## A Role for the GEF

The GEF was piloted in 1991 to do something totally new: to earmark multilateral funds for developing country-based projects with global environmental benefits. GEF's brief is to make the connection between local and global environmental challenges and between national and international resources to conserve biodiversity, reduce the risks of climate change, protect the ozone layer, clean up international waters, and stop land degradation.

Over the past seven years, the need for and potential uses of this global partnership have become increasingly clear. Most importantly, the GEF was designated the financial mechanism for both the Convention on Biological Diversity and the Framework Convention on Climate Change. Without it, these two international treaties might be gathering dust, sharing the fate of others that lacked a provision for financing implementation.

To meet its potential and fulfill multiple missions, the GEF has had to evolve from its pilot form into a more broadly representative, participatory, transparent, effective, and strategic organization. This process began even before 1994, when the GEF was "restructured" and replenished with a fund of \$2 billion.

The new GEF teamed the UN agencies most directly concerned with economic development and the environment, the UN Development Programme (UNDP) and the UN Environment Programme (UNEP), with the World Bank to implement GEF projects on the ground – creating the first strategic alliance of United Nations and Bretton Woods institutions. A GEF Council was established – balancing decision-making and rep-

resentation from developing and developed nations, and economies in transition – as was an Assembly, involving all participating states.

From these new beginnings, much has taken root and grown. The number of states participating in the GEF has grown to 161. The number of donors, from North and South, has increased to 36. Funds programmed for GEF projects in 119 countries now total \$1.9 billion, with \$5 billion leveraged from other sources.

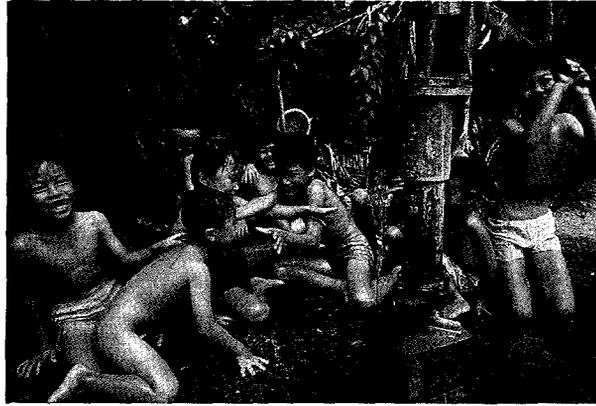
The GEF has operationalized the highest priorities of the Conference of the Parties to support the design and implementation of country-driven projects in biodiversity and climate change. It is providing economies in transition with resources to phase out ozone depleting substances and meet their obligations to the Montreal Protocol. It is underwriting partnerships among countries in order to manage shared water resources sustainably.

But the GEF is more than a channel for project financing. It is also a far-reaching and dynamic network, uniquely positioned to share global environmental science, support related policy reform, build capacity, catalyze new combinations of actors, and foster markets for environment friendly technology.

## Building Country Capacity

The GEF helps support global environmental security by integrating the global environment into national development and strengthening the capacity of developing countries to play their full part in protecting the global environment.

Over the coming months, with the GEF's help, developing countries will be completing national communications and action plans called for in the Convention on Biological Diversity and the Framework Convention on Climate Change. These are important tools for mainstreaming climate and biodiversity concerns in country think-



ing and planning, and for identifying priorities that can form the basis for formulating country assistance or cooperation strategies, as well as longer term GEF support.

## Tapping NGO Involvement

Civil society has become an important force in implementing Agenda 21 and in increasing public awareness on global sustainability, particularly at the local level. At the GEF, about one-third of the project ideas submitted by governments originate with non-governmental groups. Approximately 20 percent of the funds expended by the GEF involve NGOs in design, planning, and/or implementation. A total of 26 private foundations also are a part of GEF's work.

In terms of governance, GEF was the first – and is still the only – international financial entity to welcome NGO observers to its Council meetings. NGO representatives play a vocal and substantive role in shaping the GEF agenda in other ways as well, including participation in interagency task forces – such as the one created to design and launch the GEF's new “medium-sized projects” window.

In 1995, an experimental GEF-NGO network was established, composed of 13 regional focal points and a global one, IUCN-The World Conservation Union. Its overall goal is to support and promote the GEF mission, with a particular emphasis on supporting and galvanizing outreach efforts and

an active and constructive NGO role in the GEF process.

## Fostering Environmentally Friendly Technologies

In a modest way, the GEF has already helped developing countries and economies in transition take the first steps toward addressing the problem of climate change. The GEF has mobilized \$4.5 billion for climate change activities in over 110 developing countries. Of this, close to \$700 million was provided in grants from the GEF.

Energy policy and investment in global environment friendly technologies are key pillars for any climate change strategy and it is the private sector – not governments – that are the key players in the technology transfer arena. Net private capital flows to developing countries are almost six times official development assistance. In the GEF, we are keen on entering into bilateral (or even trilateral) partnerships with the private sector where our funds augment, not displace, private capital and where our interventions facilitate and catalyze demonstration projects with significant replication potential.

The GEF and its collaborators are also working to:

- Promote consistent, incentive oriented regulatory frameworks that internalize environmental costs, do not distort the market, and yield a level playing field for private investment.
- Facilitate the transfer of know-how and help remove institutional barriers.
- Catalyze partnerships to enable implementation of international agreements.
- Lower risks associated with innovative technologies. Through concessional lending, the GEF can provide guarantees that tip the scales in favor of investment in innovation.

In more than 150 catalytic projects, the GEF is promoting state of the art technology: photovoltaics, biomass gasifiers, wind power, geother-

mal energy, efficient industrial boilers, and improved lighting systems. In a short time and with limited funds, GEF has increased the worldwide output of photovoltaic energy alone by more than five fold.

## Multiplying the Benefits

But the GEF too has its limits. Because \$2 billion – or even \$10 billion – wouldn't be sufficient to the task, the GEF also has the mission of mainstreaming the global environment into its implementing agencies and all other national and international development budgets. It is not difficult to imagine the tremendous positive impacts on global sustainability when multilateral and bilateral development institutions fully integrate global environmental concerns and actions into their wider agenda: in other words, into all economic and sector work – in energy, in agriculture, forestry, water resources, industry, and infrastructure.

The evolutionary process the GEF took on board in the early 1990s must, in the new century, encompass all governments, development institutions, NGOs, and private business too. By strengthening the linkages between and among all these partners, we can ensure that the global environment will remain a top priority, long after discrete projects end.

## Investing in Environmental Security

Throughout history, nations have identified security threats as military and political challenges coming from a sovereign power. More recently, we have come to see the civil unrest that is the most common form of political violence in our world today as a source of wider instability. But we need to move beyond these familiar definitions to a new understanding of the global environmental situation as a very real threat to the security of nations and of the international order.

Once that shift in outlook takes hold, the resources for mounting an effective defense will follow. Once environmental concerns become a mainstream element in the strategic planning, economic calculations, and political dialogue of nations and their leaders, genuine progress toward sustainable development will also follow.

- In developing countries, an environmental defense would focus the attention of officials on subsidies for fuel consumption, for wasteful irrigation or fertilizer use, and for undisciplined logging, for example, so that they could see their real cost to both the country's development budget and to its finite supply of natural resources. It would also focus attention on building effective national institutions.
- In multilateral institutions that seek to help those countries, up-front attention to global environmental concerns would shift the burden of decision-making about a coal-fired plant, a highway project, or a forestry scheme from issues of technical and financial feasibility alone to calculations of the project's impact on the sustainability of economic development.
- In developed nations, where consumption patterns are the force that most needs curbing, a central appreciation of the global environment might lead to large-scale R & D for renewable energy technologies and rewards for producers of so-called "green" energy. It is also essential that developed countries facilitate the transfer of environmentally-benign technologies to developing countries and provide the necessary financial and technical assistance for poverty alleviation and sustainable development in countries not benefiting from foreign direct investment.

Agenda 21 opened with this hopeful observation: "integration of environment and development concerns and greater attention to them will lead to the fulfillment of basic needs, improved living standards for all, better protected and managed ecosystems, and a safer, more prosperous future.

No nation can achieve this on its own but together we can – in a global partnership for sustainable development."

The Global Environment Facility has been privileged to implement its part of this partnership on behalf of the people of the world. And it will continue to do so – in the interest of sustainable development and future generations.

*Mohamed T. El-Ashry  
CEO & Chairman  
Global Environment Facility*



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## About *Valuing the Global Environment*

... of our blue planet from outer space ...  
... the ...  
... of our planet and helped inspire the start of global environmental awareness.

Conserving what is – or may be – of potential economic value cannot be done in isolation. That thing we call 'nature' is a dynamic collection of genes, species, and ecosystems. As any builder knows, take out one stone too many and the house will collapse. We can be encouraged by two things. First, that nature is more resilient than is often supposed. And second, that even in our material world many nations are coming to see the importance of conserving their parts of the whole.

Nations have to think globally and harmonize local action to benefit the whole planet. How to do that was the problem which faced policy-makers before the Earth Summit. At Rio the world's leaders assigned that task to the Global Environment Facility."

*Harrison Ford*



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