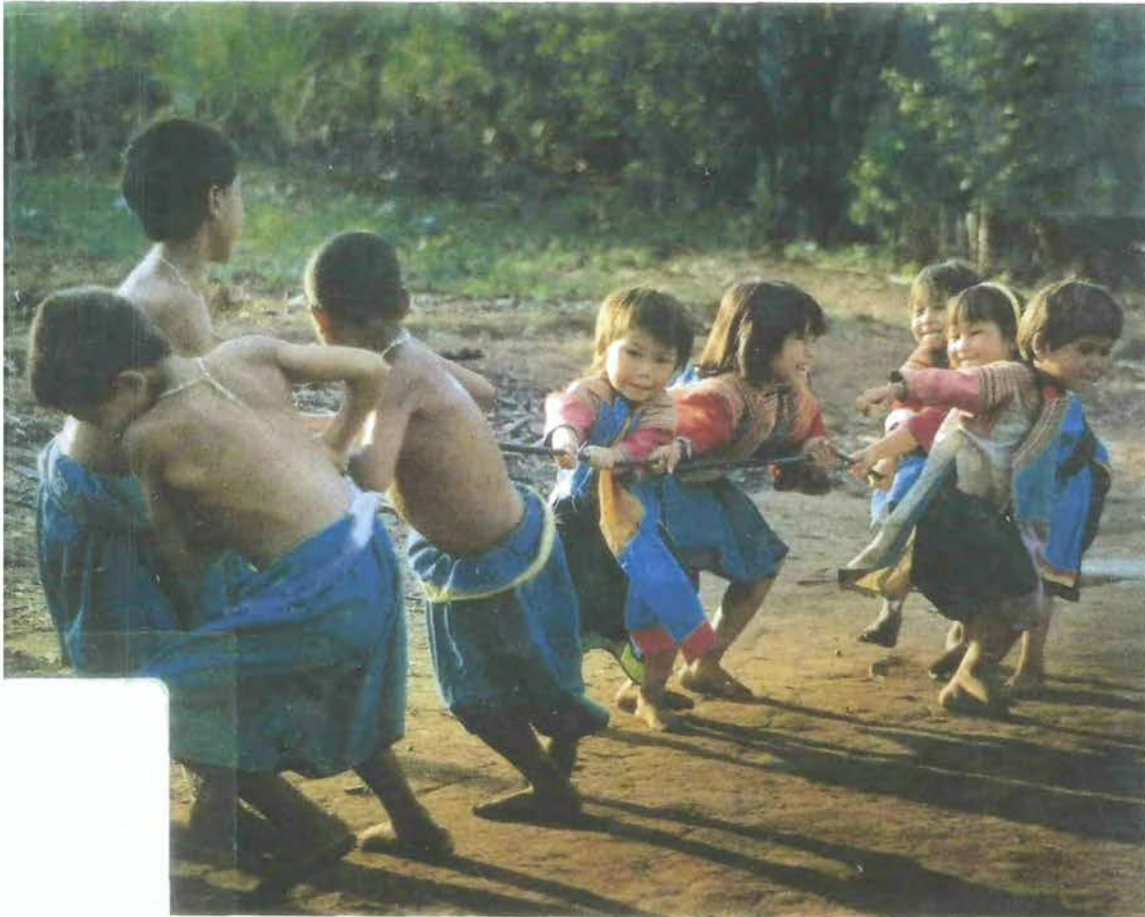


A COMMITMENT TO THE FUTURE

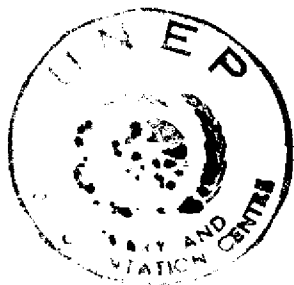
Sustainable Development
and
Environmental Protection



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A COMMITMENT TO THE FUTURE

Sustainable Development
and
Environmental Protection

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DEDICATION

This book is dedicated to all staff members of the United Nations Environment Programme – former and present – for their untiring efforts to advance the cause of the environment over the past two decades, at the national, regional and global levels. They should be proud of what they have achieved.

ACKNOWLEDGEMENTS

I am extremely grateful to my colleague Professor Essam El-Hinnawi of the Egyptian National Research Centre for his outstanding efforts in analysing more than 600 of my statements and for his assistance in the preparation of this publication. Thanks are also due to Mary Lean, who edited the manuscript into a readable and attractive form.

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PREFACE

Between 1974 and 1992 I gave more than 600 statements and lectures on various aspects of the environment to governmental meetings, scientific conferences, international gatherings and non-governmental organizations. This book is based on them. They are supplemented by a few boxes of facts and figures to highlight a particular issue or stress a point.

In some cases it was new scientific findings which compelled me to speak out. In others it was a frustration at our lack of information – or at our lack of action in spite of adequate information. Over the years scientific understanding of the functioning of the environment has galloped ahead. It has become clearer every day what a serious experiment we are involved in. It could literally cost us the Earth.

This compilation is presented in the hope that it will further clarify how serious things are. It is intended as a prelude to the Epilogue, which stresses the duty to hope and looks forward to what can be done to avoid environmental catastrophe.

There are many hundreds, thousands, of successful experiments. We must learn from them. We do not need to learn from our own mistakes. We can also learn from the mistakes of others.

Mostafa K. Tolba
Executive Director
United Nations Environment Programme
Nairobi, October 1992

PROLOGUE

There is nothing static about either 'environment' or its relationship to development. The environment – which we now see as our home – provides the resources and ecological processes which make all life possible. And development is the means by which we utilize the environment to produce goods and services. Our understanding of these processes is in a constant state of evolution.

Early human beings lived by hunting and gathering. They transformed many areas of the Earth and wiped out several animal species. Then, about 10,000 years ago, people in various parts of the world started to cultivate food plants and keep animals. They began to set up agricultural communities, exchanging the uncertainties and hardships of hunting and wandering for the routines of settlement.

During those early times, people learned that their actions could damage the natural resources by which they lived. Tree cutting, overgrazing and soil erosion undermined agricultural productivity around the Mediterranean, in southern and central China, in India and in Central America. Historical records give evidence of early attempts at conservation: religious taboos protecting some species of animals, some forest groves and plants; the use of organic fertilizer and other practices to maintain soil fertility and prevent erosion; the creation of wildlife or natural reserves. But in spite of these efforts, flourishing civilizations disappeared.

The Industrial Revolution of the latter 18th and early 19th centuries and the 20th century scientific and technological revolutions dramatically increased humanity's need for natural resources and its pressure on the environment. Overwhelmingly, this impact has been negative. Today – as we stand before a new millennium – we face an ecological crisis that has assumed planetary dimensions. The problems are so great that they threaten to derail economic development.

The technological advances in the first half of this century raised fundamental questions about the future. Could the globe continue to support its rapidly growing population? And how appropriate was the technology itself? These questions were first debated in scientific circles, but soon caught the attention of the public.

By the late 1950s public concern was rising: people had died in smog episodes in Belgium, the United States and the United Kingdom; lives had been shattered by mercury pollution in Minamata and Niigata, Japan; acidification was killing lakes in

Scandinavia and North America; birds were dying from the side effects of pollution; and oil spills had polluted the sea. This concern gathered momentum in the 1960s and culminated in the convening of the United Nations Conference on the Human Environment in Stockholm in 1972.

The Stockholm Conference was the turning point in the history of environmental awareness and action. Its Action Plan for the Human Environment, the establishment of the United Nations Environment Programme that year, and the enthusiasm of non-governmental organizations (NGOs), both at and after the Conference, gave further impetus to the environmental movement and gave it effective expression in the international community.

Thus environmentalism – once the domain of a prescient and often privileged few, primarily concerned with wildlife conservation – has broadened, both in its public support and in its scope. The movement has taken on board all aspects of the natural environment: land, water, minerals, all living organisms and life processes, the atmosphere and climate, the polar icecaps and remote ocean deeps, even outer space. What is more, the movement no longer concentrates on the natural environment alone but also addresses the interrelation between environment and human wellbeing, and between environment and such aspects of international economic cooperation as debt, commodity prices, structural adjustments and subsidies.

In the last two decades, scientific research has contributed a great deal to our understanding of the different processes that control and affect environmental systems. Much progress has been made: in devising analytical methods and instruments to determine and monitor traces of inorganic and organic pollutants; in better defining what happens to pollutants when they are emitted into various media; and in establishing their effects on materials and living organisms. We have gained impressive insights into the biogeochemical cycling of elements essential for life, such as carbon, nitrogen, oxygen, phosphorus and sulphur. And we now understand the mechanisms that could lead to ozone depletion and global warming better than we did 20 years ago.

As a result of this increased understanding, and of advances in computer technology, mathematical models perform much better than they used to and the public is more open to model-derived 'futures'. Models have been used to envisage ozone depletion, climate change, acid rain, nuclear winter and the impacts of environmental change on the biosphere. Others have dealt with the interrelationships

between resources, population growth and environment.

The last two decades have also seen the introduction of techniques of environmental impact assessment, cost-benefit analysis, risk analysis and management, natural resource and environmental accounting, technology assessment, environmental audits and the use of geographical information systems. These and other tools have improved our understanding of environmental processes and our ability to draw up policies to deal with different problems.

Thanks to this scientific progress, we now have a clearer picture of the size of the challenge. Scientific monitoring and assessment confirms that the capacity of our planet to support life is growing weaker. Synergistic, perhaps irreversible, forces are at work.

The symptoms of ecological degradation are everywhere. We have punched a hole in the Antarctic ozone layer. We face the threat of a planetary hothouse. Coastal areas and freshwater resources continue to be fouled. Millions of tonnes of pollutants spew into the air. Tropical forests are dismembered. The Earth's heritage of plants and animals faces the worst mass extinction in 65 million years. Urban areas are sprawling, productive lands retreating, deserts growing and human numbers swelling by nearly 100 million each year.

The two decades since the Stockholm Conference have seen a considerable degradation of the global environment and a further squandering of the world's stock of productive natural resources. We must accept this reality. But there are also some grounds for optimism. A growing appreciation of the global nature of the problems and their implications – not just for quality of life, but also for its very sustenance – has led to a new and more serious approach to environmental issues. Governments have displayed a greater willingness than ever before to act together to address these threats on a regional and global basis.

The late President John F Kennedy said, 'Now the trumpet summons us again, not as a call to bear arms, though arms we need, not as a call to battle, though embattled we are, but as a call to bear the burden of a long twilight struggle, a struggle against the common enemies of man – tyranny, poverty, disease and war itself.'

Thirty years later, our long twilight struggle continues. True, in many ways it has changed. We are living through one of the most exciting periods in human history. Past tyrannies and monopolies on the truth are dissolving. The shadow of global war

becomes lighter as East-West tension fades away. Yet global injustices remain. The twin enemies of poverty and disease have if anything become stronger.

The gap between rich and poor has become wider. While Western nations have enjoyed economic growth and a rise in living standards, per capita incomes in many developing countries have fallen. Millions are poorer today than a decade ago. Over a billion people live in absolute poverty. Health, education, housing and basic nutritional standards have plummeted in many nations of the global South.

These can no longer be ignored as someone else's problems, distant sufferings in distant lands. For if global interdependence means anything – and surely it does – then poverty, disease, skyrocketing populations, accelerating natural resource destruction and mounting ecological degradation are our problems, affecting each and every one of us. In this, there is no us and them. We are all in it together.

The North-South dialogue over the environment – stalled for years – has rightly assumed the urgency of disarmament talks. For in the end, both are about our future survival. But when dealing with global environmental and natural resources problems, the players are not only the superpowers. They are all countries – large and small, developed and developing. Only by working together can we defuse the global time bomb of ecological destruction and inequitable development which threatens our future.

PART 1

ENVIRONMENT AND DEVELOPMENT

ENVIRONMENT AND DEVELOPMENT

Are they compatible?

Before 1972, many developing countries were suspicious of 'environment' as a public issue on a global scale. This was partly due to the way environment was defined in those days – as a question of pollution and its abatement. It was seen as a technical question, amenable to technological, legal and administrative answers. Few today would be satisfied with this restrictive interpretation, which stemmed from the preoccupations of industrialized societies.

Developing countries were, of course, aware of the threats which uncontrolled pollution posed to the world and to themselves. They realized, too, that their own societies would increasingly have to face problems of pollution. Some leaders, at least, felt that they should avoid the mistakes already committed by the industrialized countries.

They also recognized that environmental concern in the North might have positive economic spin-offs for the South. For example, developing countries might benefit from the resiting of polluting but productive industries and from the replacement of environmentally suspect synthetic products with the natural ones they produced themselves.

Yet many developing countries had misgivings. Some saw environment as a ploy of the rich to prevent poor nations from industrializing and to keep them supplying the raw materials on which the development and prosperity of the North depended. Some argued that if pollution meant industry, they would welcome it wholeheartedly. More realistically, perhaps, some feared that their development ambitions might suffer as industrialized countries diverted aid to the 'new' problem of the environment. If anyone was going to lose out through a concern for the environment, they argued, it should be the rich countries, who were largely responsible for pollution.

Developing countries also feared that environmental concerns would impose extra burdens upon them – for instance, that stringent standards might put up the cost of imported technology and machinery. They suspected that their export trade would be harmed by the environmental regulations industrialized countries were likely to adopt.

All in all, therefore, environment and development were seen as being in conflict. It was feared that a commitment by the international community to environment was likely to detract from its commitment to development.

BOX 1.1

The kind of environmental problems that are of importance in developing countries are those that can be overcome by the process of development itself.
The Founex Report (1971)

The protection and improvement of the human environment is a major issue which affects the wellbeing of peoples and economic development throughout the world.
The Stockholm Declaration (1972)

The problem today is not primarily one of absolute physical shortage but of economic and social maldistribution and misuse.
The Cocoyoc Declaration (1974)

It is essential that the mutually dependent relationships between development and environment be fully and explicitly taken into account.
Choosing the Options (1980)

Health, nutrition and general wellbeing depend upon the integrity and productivity of the environment and resources.
International Development Strategy for the Third United Nations Development Decade (1980)

In 1971, a panel of experts from both developed and developing countries met in Founex, Switzerland, to clarify the issues and point out the links between development and environment. The panel identified many serious environmental problems which were largely concentrated in the Third World.

The environmental problems of the South are very often the result of extreme poverty and the lack of economic and social development. For example, it is in the developing countries that water quality, housing standards, sanitation and nutrition are lowest, disease most prevalent and natural disasters most destructive. It is there too that the destruction of vital natural resources – such as soil, vegetation and wildlife – is most alarming, and the impact of a fast growing population most apparent.

The panel also showed that problems already distressingly familiar to richer countries

would emerge in developing ones, perhaps sooner than many realized, as their industry, agriculture, transport and communications expanded. There were differences between the problems of rich and poor countries, but also many shared concerns. The panel established beyond doubt that developing countries faced vast environmental difficulties of their own.

A new understanding of the relationship between environment and development emerged from Founex and the Stockholm Conference. Firstly, the concept of environment was expanded. A more holistic approach, encompassing the socio-economic factors which lie behind many of the problems, replaced the old technocratic approach, with its heavy emphasis on the natural sciences and on consequences rather than causes. The link between development and environment was clarified.

The aims of development were also redefined, to make quality of life, rather than a limitless pursuit of material possessions, the main criterion of success. Developing countries came to appreciate the need to incorporate environmental considerations into their development efforts. Finally, it was clear that an already complex issue had become even more complex and that the environmental agenda must be expanded.

Thinking advanced further at the Cocoyoc Symposium on Patterns of Resource Use, Environment and Development Strategies in 1974, which was jointly organized by UNEP and UNCTAD. It agreed on six main points.

First, economic and social factors were often the root cause of environmental degradation. Patterns of wealth, income distribution and economic behaviour, both within and between countries, obstructed development and led to inequities.

Second, meeting the basic needs of the world's population was a chief goal for the international community and nation states. The needs of the poorest strata of mankind were particularly urgent, but they must be met without impinging upon the outer limits of the Earth's carrying capacity.

Third, different nations, and groups within them, placed widely differing demands on the biosphere. Access to many cheap natural resources was pre-empted by the rich. However, it was not only the rich who wasted natural resources: the poor were often left with no option but to destroy them.

Fourth, developing countries must develop their own self-reliant approach to development, rather than following in the footsteps of the industrialized countries.

Fifth, the search for alternative patterns of development and lifestyles, in both developed and developing countries, was the principal means of achieving environmental and development goals.

Finally, this generation must look ahead and not so pre-empt the planet's limited resources or pollute its life support systems that it jeopardized the wellbeing – even existence – of future generations.

Environmental and development objectives are complementary. If we look upon environment as the dynamic stock of physical and social resources available at a given time for the satisfaction of human needs, and upon development as a universal process aimed at increasing human wellbeing and maintaining it long term, we will have no choice but to direct development along lines that are environmentally appropriate.

Already in 1974, I pointed out to the World Food Conference convened in Rome that any strategy to increase food production on a sustained basis must explicitly take account of the interdependence between environment and development. The aim must be to maximize food production without destroying the ecological basis for continuing production – a process I have called 'development without destruction'.

A new kind of development

Since the early 1970s, there has been a search for a new, more rounded concept of development, in which environmental considerations play a central role.

There is no question it is needed. Development must be related to the ways in which the natural resource base limits and creates opportunities for human activities. It is now clear that past patterns of development in both developed and developing countries have been characterized by such serious environmental damage that they are simply not sustainable.

What are the features of this new kind of development? Three aspects are particularly important: it has implications for all countries, rich and poor; it presupposes new directions for growth and development, not their cessation; and it incorporates the environmental dimension.

There are, however, important differences in the forms it would take in industrialized and developing countries. In the industrialized countries it will be necessary to reorient societies' aims in ways that place less demand on natural resources, energy and the environment. The entire population must be given more opportunity for self expression

«The world is today not only faced with the anomaly of underdevelopment. We may also talk about overconsumptive types of development that violate the inner limits of man and the outer limits of nature. Seen in this perspective, we are all in need of a redefinition of our goals, of new development strategies, of new lifestyles, including more modest patterns of consumption among the rich. Even though the first priority goes to securing the minima we shall be looking for those development strategies that also may help the affluent countries, in their enlightened self interest, in finding more human patterns of life, less exploitative of nature, of others, of oneself.»

The Cocoyoc Declaration (1974)

in the fields of culture, education, the arts and humanities – those non-physical areas of development which represent the highest levels of human achievement.

Present patterns of production and consumption, based on waste, extravagance and planned obsolescence, must be replaced by patterns based on conservation and re-use of resources. I am encouraged by signs from several industrialized societies that such a reorientation of lifestyles and aims can now be discussed seriously, though clearly the change implied is an immense one, which will take many years.

The developing world still lacks the infrastructure and readily useable resources to meet the growing needs and aspirations of its people. There the new kind of development must continue to have a strong physical orientation.

Each developing country should be helped to follow the path best suited to its needs and to its culture and value systems. Countries should be given access to the technologies that they require and enabled to adapt them to their own needs, rather than have alien technologies dictate or distort their development process. Most of all, new approaches in these countries should be based on environmentally sound development of soil, water, plant and animal resources so as to avoid the destruction of the base on which their future depends.

The rich industrialized countries are heavily committed to the technological status quo – even though it may already be inefficient. Some economies, for instance, are so geared

to the production of private cars that their railway and public transport systems are inadequate. Radical and rapid changes of direction are difficult for such economies.

The overdeveloped cannot take quick advantage of technological innovations which conserve resources, require a greater input of human labour or compromise production patterns in which large investments have been made. Such advances favour countries on the threshold of a more modern development and may give them competitive advantages as yet unconsidered. In many respects, a more efficient form of development may now be easier for developing countries than for developed ones.

We have not come to the end of the age of discovery of our inner space, our biosphere. We stand on the threshold. Many advances, to the benefit of all, may yet await us as we seek to learn from natural processes. In harmony with them, we may further our welfare.

The power of the tides and currents, the secrets of the genetic diversity and biochemical complexity surrounding us are among many features of our world still to be explored. And yet these are the riches, full of promise, which we compromise through heedless actions, mighty in their power for destruction yet dependent on natural processes if they are to yield the fullest benefit.

Food does not grow exclusively, mostly or even largely because of man's efforts. Our efforts succeed because of the natural properties of the soil and the micro-organisms which live in it, the biological absorption and use of nitrogen, the energy of the sun. More pests are controlled by their natural predators than by chemical means. Such examples can be multiplied and point to the great scope of services provided by the natural environment.

These processes are our natural partners, whose worth we supplement by our efforts, whose destruction violates the outer limits and causes irreversible and irretrievable damage. Yet each year we add to the biosphere thousands of new chemical compounds unknown in nature and, in terms of their long term effects on our children and their children, equally unknown to us. Each year we engage in actions which may compromise the ozone layer by permitting increasing quantities of biologically significant ultraviolet radiation to pass through it at considerable risk to our health and wellbeing.

It is entirely unrealistic to believe that the future is best assured by a development process which does not recognize our interdependence with the tropical forests, with

the maintenance of the ozone layer, with the common services provided by the environment and the natural resources available to us. It is a singularly ineffective development which exploits the present without regard to future consequences.

The world of the future may, as some forecast, be a gloomy prospect. But it may equally well be a world which combines planned use of the wealth of the biosphere and the opportunities offered by new discoveries to assure the wellbeing of future generations.

In our linkages with the biosphere, in a better understanding of the complex biological, biochemical, ecological, socio-economic and technological factors affecting the process of development, lie the clues to furthering our welfare through new kinds of development.

Sustainable development

At the beginning of the 1970s, the Club of Rome formulated the 'limits to growth' theory. The idea was that the planet's physical limits were being reached. What had seemed infinite to a relatively small human population was now alarmingly finite. If we pushed beyond those limits, the Earth's environment would break down, lose its ability to sustain us and our industries and our agriculture. We would be the end losers.

Of course, the theory is only partly correct – as was shown by later studies, including those of the Club of Rome itself. But it was an eye opener. For we now have the ability to destroy the environment completely. In so doing we will write off the economic machine which feeds 5 billion people.

A gruesome illustration of the Club of Rome theory is to be found in the African Sahel, and most dramatically in the Horn of Africa. These countries are at risk of dying. Populations have increased with the advances of modern medicine and with the advent of better transportation of food. But the land is being overworked. Famine is taking its hold, on a larger scale and with greater frequency than ever before. When food aid is brought in lives are saved for the time being and more children are born, but the land remains the same and the chances of another famine increase.

It is wrong, however, to say that destruction is a necessary consequence of growth. Growth is only destructive if it ignores the limits of the environment. Some elements of the environment are limited, some are not.

The Club of Rome initially assumed that all resources were limited. They pointed to the oil crisis and to the impending dearth of all petroleum products. They pointed out

that renewable resources could only be exploited at the margin and that in most cases we had already crossed the margin of increase. They pointed out that many of the world's fish populations were declining due to overexploitation. They pointed out that more species had been extinguished during the 20th century than in the last million years. Resources that could have sustained a smaller population forever were being snuffed out.

They were right. But they ignored the fact that the Earth still has an essentially infinite supply of sunlight, and that that resource is still largely untapped except through natural means such as photosynthesis and the cycling of water between the oceans and atmosphere. They also ignored the fact that many of man's economic activities can be effectively altered to make them work with the biosphere instead of in competition with it.

The World Commission on Environment and Development has given a powerful example of this in its report *Our Common Future*, published in 1987. The Commission pointed out that most of the new wealth created in the 1980s was created in non-polluting industries. It was the service industries such as information and data which were the hub of present growth.

This growth which works in tandem with the environment is what we call 'sustainable development'. Sustainable development will be the foundation of economic and social planning in the next century. If it is not, Malthusian laws will take over again. What we see in the Horn of Africa will spread and will take its toll on the whole Earth. Famine in Africa, flooding in South Asia, and the proliferation of small wars are signs of what could happen to a world which fails to regulate its growth according to the constraints of the biosphere.

So what is sustainable development and how much will it cost us to put it into practice? Is it possible to do this in the next generation? Let us take an example, that of the agrochemical industry.

The total cost to society of the agrochemical industry is not simply the sum of the expenditure of manufacturers and consumers. The agrochemical industry is responsible for the eutrophication (overenrichment) of freshwater systems; it is responsible for industrial accidents during manufacture (such as the accident in Bhopal that killed over 2,000 people and injured up to a quarter of a million others). It is also responsible – and this may prove to be the most important point – for

skewing the terms of trade against primary producers; for while the cost of chemical fertilizers has been rising steadily in recent decades, the return on agricultural produce has remained more or less static in real terms and in some cases has markedly declined.

Modern agriculture has steadily increased the amount of chemical fertilizer that is applied to the soil. After a time crop growth reaches a limit and a law of diminishing returns takes hold: the yield per unit of fertilizer falls. Distribution techniques are necessarily wasteful to some degree, and unassimilated fertilizer is carried through the soil into the freshwater system, setting in motion the intense eutrophication which is so costly to the catchment authorities of the North American prairies, Western Europe and other major users of chemical fertilizers.

The same pattern is true of pesticides. The law of diminishing returns takes hold because pests become resistant. The cost to the farmer increases, but so does the cost to society as the toxic chemicals enter the food chain and eventually accumulate in people's bodies.

Even ignoring the effect on society in general, the overall economic productivity of agricultural chemicals – that is, the crop output per cost unit of chemical input – has decreased by 50 per cent since 1960 and is still falling.

This shows that increasing environmental damage and declining economic output are both inherent in the present system of agricultural production. Nowhere is this more apparent than in Latin America. Small farming in Latin America is marked by an increasing number of bankruptcies, while larger scale agriculture is characterized by overindebtedness, poor foreign exchange earnings and declining productivity.

Each year, as agrochemicals become more expensive and less efficient, farmers and national treasuries must incur a higher debt to buy the chemicals and thereby become more vulnerable to bankruptcy. The need for ever more sophisticated chemicals forces farmers to turn increasingly to manufacturers in the developed world at a time when exchange rates are declining against the Western basket of currencies.

One might reasonably assume that under free market conditions the present arrangement would collapse when importers of agrochemicals no longer made any gain from their farms. This is partly true, and partly explains the steady rate of migration to the cities in Latin America and elsewhere. But when it comes to larger enterprises, there is another factor. Producers and exporters of agrochemicals are

interested in expanding output. They have an interest in keeping any system going which increases consumers' dependence on their product. They have no interest in investing in or supporting alternatives.

In terms of sustainable development, the alternative would be a system of agricultural production which maximized renewable resources and reduced waste. One example is integrated pest management. Instead of attacking boll weevils with chemicals, why not introduce predators which would increase in number so long as there were boll weevils to eat, but would decline again when the pests were gone? It sounds good in theory, but does it work? And can it become the mainstay of agricultural production in the next century?

The answer is yes. Overall production is often not as high in the short term as in chemical-intensive farms, but net returns are in some cases just as good or better, despite a lack of experience and the small scale on which organic farms tend to operate.

Production costs are lower, chemical waste is eliminated altogether and environmental clean-ups become a thing of the past. But it is not in the interests of the producers of agrochemicals to encourage integrated pest control. Even bilateral agencies are sometimes wary of promoting production techniques which would jeopardize national exports.

This disincentive for major corporations to invest in sustainable systems of production can be glimpsed in the slow progress of integrated pest management and of solar energy, and in the demise of the electric car.

Yet surely there is a better way. Surely the planet as a whole – and its poorer parts in particular – will benefit enormously by opting for systems of production that adapt to the working of the ecosystem. By trying to bend the biosphere to fit wasteful systems of production, we undermine the environment and we return profits only to those who control the industries concerned. We should remember that in almost all industries there is a choice of technologies. Man's ingenuity is much more flexible than the limits of the biosphere.

For two decades, UNEP has laboured to define the parameters of sustainable development. We have learned that they are very wide, encompassing economic and fiscal policies, international trade, industrial strategies, technology applications, the rights of workers, living conditions, natural resource conservation and pollution

reduction. The forces that determine environmental conditions are also the nuts and bolts of development.

In 1987 *Our Common Future*, the report of the World Commission on Environment and Development, was released, at around the same time as UNEP released its own report, *Environmental Perspective to the Year 2000 and Beyond*. The reports are complementary; both were called for by the 1983 Governing Council of UNEP. Both elaborated environmental strategies for agriculture, health, transport, urban planning and other key economic sectors.

At the core of the concept of sustainable development is the requirement that current

BOX 1.2

Sustainable development ... meets the needs of the present without compromising the ability of future generations to meet theirs ... on the basis of prudent management of available global resources and environmental capacities and the rehabilitation of the environment previously subjected to degradation and misuse ... Although it is important to tackle immediate environmental problems, anticipatory and preventive policies are the most effective and economical in achieving environmentally sound development.

Environmental Perspective to the Year 2000 and Beyond (1987)

Critical objectives for environment and development policies that follow from the concept of sustainable development include:

- * reviving growth
- * changing the quality of growth
- * meeting essential needs for jobs, food, energy, water and sanitation
- * ensuring a sustainable level of population
- * conserving and enhancing the resource base
- * reorienting technology and managing risk
- * merging environment and economics in decision making

Our Common Future (1987)

practices should not undercut future living standards. In other words, present economic systems should maintain or improve the resource and environmental base, so that future generations will be able to live equally well or better. Sustainable development does not require the preservation of the current stock of natural resources or any particular mix of human, physical and natural assets. Nor does it place artificial limits on economic growth, provided that growth is both economically and environmentally sustainable.

Two points, however, are crucial. First, there is nothing new about the link between environment and development and the criteria for sustainable development. We have grappled with them for some time. Sometimes we have succeeded. But too often development has proceeded as usual, becoming the cause – instead of the cure – of ecological destruction.

Secondly, we remain at the starting gate of policy implementation. Economic priorities and ecological goals still echo a dialogue of the deaf – both sides presenting generalist critiques and simplistic alternatives. Too much rhetoric; too much lip service; too little action.

Of course, there are no quick fixes. Sustainable development is not a ready made policy menu. It is a demanding series of concrete, costed and draconian reforms which confront failed economic policies and instigate new structural adjustment programmes. These reforms work to alleviate poverty, meet basic human needs and put to rest economic conditions that promote environmental destruction. Throughout the global South, a rigidly unfair, protectionist international economic order, commodity price volatility, crippling debt and poverty all tighten the stranglehold of natural resource destruction, chronic pollution and skyrocketing population.

Governments must set guidelines for themselves and for private enterprises that give real, short term material incentives for sustainable development.

Free marketeers will be appalled by this suggestion, at a time when liberalization of the economy is so fashionable. I would simply refer these people to the works of Adam Smith. The father of capitalism never suggested that private enterprise should work to the detriment of society as a whole. Quite the opposite. He spoke of the market system as one in which the profit of every individual brushes off on the wider community (in terms of increased employment, for instance) – much the same way as the bee gathers pollen for its own uses, but in so doing pollinates the flowers,

« The need for alternative, more sustainable patterns of development has long been recognized. At the turn of the century, the great Mahatma Gandhi expressed this need extremely well when someone asked if he would like a free India to become like Great Britain.

'Certainly not,' he replied, 'if it took Britain half the resources of the globe to be what it is today, how many globes would India need?' »

M. K. Tolba, *Sustainable Development*, Butterworth 1987

enabling the system to continue in future years. Adam Smith would have been horrified at a system which knowingly undermined its future.

I am not saying that government interference is good at all levels. That depends on the country, the culture, on a thousand factors. What I am saying is that there must be a system for channelling productive enterprise towards the goals of sustainable development. This should be a legislative priority for any government which has an interest in the affairs of the next century.

« We have faith in the future of mankind on this planet. We believe that ways of life and social systems can be evolved that are more just, less arrogant in their material demands, more respectful of the whole planetary environment. The road forward does not lie through the despair of doom-watching nor through the easy optimism of successive technological fixes. It lies through a careful and dispassionate assessment of the 'outer limits', through the cooperative search for ways to achieve the 'inner limits' of fundamental human rights, and through all the patient work of devising techniques and styles of development which enhance and preserve our planetary inheritance. »

The Cocoyoc Declaration (1974)

PART II

GLOBAL ENVIRONMENTAL ISSUES

THE OZONE LAYER

The road to Montreal and beyond

September 16, 1987, was a historic day. At a meeting in Montreal, 21 nations and the EC agreed to control the substances which deplete the ozone layer. The Montreal Protocol was the first truly global environmental agreement and the first to address a problem which had still to occur. But the road to Montreal was not an easy one.

The atmosphere has evolved over geological time into a mixture of some 80 per cent nitrogen and 20 per cent oxygen. It also contains many trace gases, in concentrations ranging from a few points of a per cent down to a few parts per trillion. Their biochemical, geochemical and geophysical importance is much greater than their relatively low concentrations might suggest.

This is particularly true of ozone, which is produced and destroyed at a wide range of altitudes in the atmosphere. Near the ground, ozone is a potentially harmful pollutant, formed when emissions from cars and industry react with sunlight. But between 25 and 40 kilometres up in the stratosphere, ozone is formed naturally from molecular oxygen and is a blessing. Although its concentration is only about 10 parts per million by volume, it acts as a natural filter which absorbs and blocks the dangerous shortwave ultraviolet radiation (UV-B) of the sun.

Ozone exists in equilibrium in the stratosphere, being formed from molecular oxygen and being destroyed by ultraviolet radiation. Reactive chemicals – such as the oxides of hydrogen, nitrogen and chlorine – can accelerate the process of ozone destruction and thus upset the natural balance, leading to a net reduction in the amount of ozone. Each molecule of these chemicals acts as a catalyst, destroying many – even thousands – of molecules of ozone before being removed from the stratosphere through interaction with other free radicals, and sinking down into the troposphere.

Concern that human activities were destroying stratospheric ozone began in the late 1960s and concentrated on high flying supersonic aircraft. Their engines become so hot that they convert atmospheric nitrogen and oxygen into nitrogen oxides (NO_x) and deposit these 17 to 20 kilometres up in the stratosphere. The NO_x then destroys ozone. But when plans to build fleets of commercial supersonic aircraft were abandoned, this concern faltered.

In 1974, two scientists working at the University of California – Professor Sherwood Rowland and Mario Molina – advanced the hypothesis that chlorofluorocarbons (CFCs) rise to the stratosphere and cause a catalytic reaction which destroys ozone. As CFCs were used in homes and industry – in spray cans, cooling systems, foam blowing and as solvents in the electronics industry, for example – the suggestion set alarm bells ringing.

Early in 1977, UNEP convened a meeting of experts. It adopted a 21 point World Plan of Action on the Ozone Layer and gave UNEP the responsibility for collating, disseminating and encouraging research. UNEP set up a Coordinating Committee on the Ozone Layer (CCOL) to help it coordinate the research programme and its output and to carry out regular assessments of ozone layer modification and its impacts.

At this stage there was no *prima facie* case against CFCs. But some governments were already anxious. In 1976, Canada had announced that it would order the progressive elimination of the most common CFCs (11 and 12) and prohibit their use in non-essential spray cans. In 1978, the USA banned the use of CFCs as aerosol propellants. Some large chemical companies began to look into developing safe substitutes.

The worldwide investigation of the extent, composition and photochemistry of the ozone layer accelerated. Data were collected from ground stations, balloons, rockets, satellites and from spaceships carrying instruments and scientists. Between 1977 and 1985, UNEP, working through the CCOL, was able to publish seven separate assessments of the severity of the threat, in the light of developing knowledge of atmospheric processes and of the trends in the release of chemicals into the atmosphere.

In 1984/1985, Dr Joe Farman of the British Antarctic Survey dropped a scientific bombshell. Comparing measurements taken in the Antarctic spring (September-October) of 1984 with records compiled from the Antarctic since the 1950s, he found that the ozone layer over the continent had been declining sharply since the late 1970s. Each spring since 1957, the ozone layer had thinned by about 40 per cent. In effect there was a 'hole' in the ozone layer over the Antarctic as big as the United States and as deep as Everest, spreading north over Argentina and New Zealand.

Why this should happen over the Antarctic was not then known. It had been postulated that the depletion was a natural phenomenon linked to the solar cycle, caused by enhanced levels of nitrogen oxides produced by increased solar activity. Later analyses, however, showed a striking correlation between low concentrations of

Antarctic ozone and high concentrations of halogen compounds. While this was not absolute proof that halogenated source gases (such as CFCs) cause the depletion, it seemed to be consistent with the hypothesis.

Against this background, a conference was convened in Vienna in March 1985, to consider the recommendations of a group of scientific and legal experts which had been working since 1981, under the auspices of UNEP and the World Meteorological Organization (WMO), on a treaty for the protection of the ozone layer. The Vienna Conference adopted the Convention for the Protection of the Ozone Layer which committed governments to 'take appropriate measures to protect human health and the environment' from the potentially adverse effects of human activities on the ozone layer.

In other words, the community of nations decided – on the basis of scientific observations and warnings – to take advance action against a distant threat and not to wait for incontrovertible proof of cause and effect, which might come too late to avoid irreparable harm.

In 1986, the US National Aeronautics and Space Administration (NASA) – whose satellites had produced the spectacular infrared maps of the Antarctic 'hole' – estimated that a 3 per cent increase in CFC emissions could deplete the ozone layer by about 10 per cent by 2050. That same year the US Environmental Protection Agency said that if CFC emissions continued at recent rates, the resulting extra UV-B radiation could cause 40 million more skin cancer cases and 12 million more eye cataracts over the next century in the United States alone. At about the same time, Swiss scientists reported evidence of an Arctic 'hole' over Spitzbergen, with the ozone layer thinning as far south as Switzerland.

The distant threat was clearly coming nearer. Pressure for global regulations and limits on CFC emissions was growing. There was some resistance: some governments thought action was premature. But fortunately most governments, most scientists and most manufacturers were talking about prudence, about action, about not gambling with the composition of the atmosphere and the future of the planet.

In April 1987, a crucial scientific meeting was held at Würzburg in Germany under the auspices of UNEP. At it, modellers from both sides of the Atlantic agreed that, under given assumptions for CFC emissions, ozone depletion would continue, whatever regulations were put in place. The central question was how great this

depletion would be. It was not enough, the experts maintained, to control emissions of CFCs 11 and 12. Models showed that CFC 113 (used in solvents) would play a significant role in the ozone equation, as would halons (primarily used as fire extinguishers), especially 1211 and 1301. The modellers also warned that changes in the vertical distribution of ozone – likely even if depletion was held to the minimum – could contribute to greenhouse warming.

The meeting came down firmly in favour of controls. Without them, they said, changes to the ozone layer would certainly increase cancer and would probably affect agricultural production, atmospheric pollution and the climate.

These scientific conclusions had a crucial impact on the vital political and legal negotiations which preceded the Montreal meeting of 1987. The Montreal Protocol on Substances that Deplete the Ozone Layer (see Box 2.1) was signed in September 1987, entered into force on 1 January 1989 and was amended in June 1990 in London. The

BOX 2.1 THE MONTREAL PROTOCOL (1987)

The Montreal Protocol on Substances that Deplete the Ozone Layer was adopted in September 1987 and entered into force on 1 January 1989. As of 31 August 1992, 84 countries and the EC had become parties to the Protocol.

THE CONTROLS

CFC-11, CFC-12, CFC-113, CFC-114 and CFC-115:

- * As of 1 July 1989, and within 12 months, and thereafter, the level of consumption and production should not exceed the 1986 level.
- * As of 1 July 1993, and within 12 months, and thereafter, the level of consumption and production should not exceed 80 per cent of the 1986 level.
- * As of 1 July 1998, and within 12 months, and thereafter, the level of consumption and production should not exceed 50 per cent of the 1986 level.

Halons 1301, 1211 and 2402:

- * As of 1 February 1992, and within 12 months, and thereafter, the level of consumption and production should not exceed the 1986 level.

original Protocol was, of course, a reflection of the state of the art at the time.

The Montreal Protocol was historic for four reasons; it was the first truly global agreement on protecting the environment; it was the first to look ahead and act to pre-empt a distant threat; it was flexible enough to permit further limitations based on new scientific evidence; and it set a precedent for concerted action by North and South to address other dangers to the environment.

Few international agreements – and certainly no environmental treaty – have received so much support and so quickly. Within five years of its adoption, 84 countries and the EC had joined the Protocol. The Protocol was a catalyst for decisions and action, involving governments, industry, business, NGOs, the public and the media. The ripples spread in every direction.

Immediately after it was signed, Finland, the Netherlands, Norway and Sweden said that they would reduce the use of CFCs faster than the Protocol required. Japan indicated that it would help finance the search for safer substitutes. The US chemical company, Dupont, said that it intended to phase out CFC production by the end of the century and intensify its research into alternatives. Japan's Asahi Glass Company reported that 14 chemical companies from the US, Europe, Japan and South Korea planned to cooperate on testing the safety of potential substitutes. Packaging groups, cosmetic companies and fast food chains stated that they would stop using materials based on CFCs.

After the Montreal Protocol was adopted, the direct link between man-made chemicals containing chlorine and bromine and ozone destruction was confirmed. The sudden, significant and repeated depletion of stratospheric ozone over the Antarctic in springtime is caused by CFCs and other chemicals. Similar perturbations, that could result in significant depletion, exist over the Arctic.

Improved models indicated that if CFC production continued at the 1980 rate, the steady-state reduction in total global ozone could be up to 3 per cent over the next 70 years. Analyses of total-column ozone data showed that ozone concentrations in the northern hemisphere between 30°N and 64°N fell by between 3 and 5.5 per cent between 1969 and 1988.

While industrialized countries were the main source of ozone depletion, two points were clear. First, the effects of ozone depletion were global. The impacts of increased UV-B radiation would affect all people in all regions. Second, action by the current

BOX 2.2 ADJUSTMENTS TO THE MONTREAL PROTOCOL (LONDON, 1990)

CFC-11, CFC-12, CFC-113, CFC-114 and CFC-115:

* From 1 July 1991 to 31 December 1992, and thereafter, the annual level of consumption and production should not exceed 150 per cent of the 1986 level.

* As of 1 January 1995 and within 12 months, and thereafter, the annual level of consumption and production should not exceed 50 per cent of the 1986 level.

* As of 1 January 1997 and within 12 months, and thereafter, the annual level of consumption and production should not exceed 15 per cent of the 1986 level.

* As of 1 January 2000 and within 12 months, and thereafter, consumption and production should be zero.

Halons 1301, 1211 and 2402:

* As of 1 January 1992 and within 12 months, and thereafter, the annual level of consumption and production should not exceed the 1986 level.

* As of 1 July 1995 and within 12 months, and thereafter, the annual level of consumption and production should not exceed 50 per cent of the 1986 level.

* As of 1 January 2000 and within 12 months, and thereafter, consumption and production should be zero.

major users and producers alone would not yield the required result. Developing countries too must phase out ozone depleting chemicals and adjust to benign ones.

Even if every country complied with the control measures of the original Montreal Protocol, atmospheric chlorine levels would double or even triple during the next century. The Antarctic ozone 'hole' would never recover and an Arctic 'hole' would probably appear. So, in 1989, I proposed the complete phase-out of all fully halogenated CFCs, as well as the control of halons and two other destructive chemicals, carbon tetrachloride and methyl chloroform. (In April 1987, I had proposed a complete

BOX 2.3 AMENDMENT TO THE MONTREAL PROTOCOL (LONDON, 1990)

CFC-13, 111, 112, 211 to 217:

* As of 1 January 1993 and within 12 months, and thereafter, the annual level of consumption and production should not exceed 80 per cent of the 1989 level.

* As of 1 July 1997 and within 12 months, and thereafter, the annual level of consumption and production should not exceed 15 per cent of the 1989 level.

* As of 1 July 2000 and within 12 months, and thereafter, consumption and production should be zero.

Carbon Tetrachloride:

* As of 1 January 1995 and within 12 months, and thereafter, the annual level of consumption and production should not exceed 15 per cent of the 1989 level.

* As of 1 January 2000 and within 12 months, and thereafter, consumption and production should be zero.

Methyl Chloroform:

* Phase out production and consumption by 2005, with intermediate cuts of 30 per cent of the 1989 level by 1995 and 70 per cent by 2000.

All CFC substitutes (HCFC-21, 22, 31, 121-4, 131-3, 141, 142, 151, 221-6, 231-5, 241-4, 251-3, 261, 262, 271) have been included on a separate list with a requirement for annual reports on production and consumption, strict guidelines for their use plus a commitment to phase them out within a specified period. The replacement HCFCs have lower atmospheric lifetimes and lower chlorine loading potentials than fully halogenated CFCs and are therefore less ozone depleting. They are considered as 'bridging' chemicals that should be phased out by 2020-40. Completely acceptable substitutes for long term use must have no ozone depleting or global warming potential.

phase-out of CFC production and use by the year 2000, but a majority of governments strongly resisted the proposal. Since then, many had come to support it.)

In 1989, the parties to the Montreal Protocol established four review panels to prepare assessments of the scientific, environmental, technological and economic aspects of the ozone problem. The results of these and other studies showed that the problem was much more imminent and severe than the previous consensus had indicated.

The studies showed that a 1 per cent reduction in the amount of stratospheric ozone would lead to a rise of some 2 per cent in the amount of UV-B radiation reaching the ground. Exposure to increased UV-B radiation can inhibit the body's immune system, which might lead to a rise in the occurrence or severity of infectious diseases. It has also been estimated that each 1 per cent decrease in total-column ozone will lead to a 0.6 per cent rise in the incidence of cataracts – or 100,000 more people going blind every year – and to a 3 per cent rise in the incidence of non-melanoma skin cancer – or 50,000 more cases per year. Cases of the more dangerous cutaneous malignant melanoma may also increase and the increased radiation will also alter the productivity of some plants and aquatic organisms.

When the parties to the Montreal Protocol met in London in June 1990, they agreed to phase out CFCs and halons by 2000 and set a timetable for phasing out other compounds (see Boxes 2.2 and 2.3). A multilateral fund involving UNEP, UNDP and the World Bank was set up, to be financed by contributions from industrialized parties to the Protocol and from those developing countries with a per capita consumption of more than 0.3 kilograms of the controlled substances per year. The fund will help other developing countries meet the costs of complying with the revised Protocol and provide for the transfer of technology. The parties also agreed to a decision making mechanism for the fund in which developed and developing countries have equal representation.

The world community only succeeded in reaching such rapid agreement because of the support of scientific research. Firm scientific conclusions made for firm policy decisions. Research and assessment – provided for by the Convention and Protocol – are a continuous and evolving process.

In 1991 a joint meeting of the WMO and UNEP identified on-going objectives for research. They included improving existing models; setting up more ozone measuring stations, particularly in the Arctic, eastern Siberia and the tropical belt; further

research into the extent and effects of ozone depletion, particularly on climate, and into how ozone-affecting substances behave in the atmosphere. They also urged further study of the health and socio-economic effects of increased UV-B radiation, with a particular emphasis on food production in developing countries.

An important recent presentation was made by an Argentine from Tierra del Fuego at the United Nations Conference on Environment and Development in Rio de Janeiro in June 1992. He presented a report by US scientists which showed that levels of UV-B radiation in Tierra del Fuego are already double those found at a baseline monitoring station in California. His claim that the children of his province are now at risk from skin cancer and glaucoma is completely justified. With similar levels of ozone depletion now expected over northern Europe and parts of North America, as well as over Australia and New Zealand, the prognosis is grim.

Almost as alarming as the public health emergency is the looming threat to the food chain. The productivity of phytoplankton and other micro-organisms in the Southern Ocean may already have fallen by as much as 20 per cent. This situation can be expected to worsen. Global fisheries – already strained, with some stocks at a 20 year low – will almost certainly decline.

These and other recent findings have led to calls for further tightening of the London Adjustments and Amendment of the Montreal Protocol. The matter will be discussed again at the Fourth Meeting of the Conference of the Parties to the Montreal Protocol to be convened in Copenhagen later in 1992, where such measures are expected to be approved.

Nothing less than the complete phase-out of all depleting chemicals will enable us to restore the ozone shield. And even this is a long healing process. If phase-out is achieved by 2000, the Antarctic ozone layer may begin to recover in about the year 2060: a long way off.

The 'possibility' of restoration may seem too abstract, too remote in the light of immediate difficulties. But we must act, for the sake of the younger generation and of unborn generations to come. It would be completely irresponsible – even immoral – to leave a dangerous world for our children and grandchildren to live in.

CLIMATE CHANGE

Facing up to global warming

The world's climate has always been in a state of flux, but until recently man's role in this has been minimal. The agricultural and industrial revolutions have changed all that. The activities of 5 billion human beings are now the main motor of change.

We have known in theory since the turn of the century that a build-up of carbon dioxide in the atmosphere could affect the world's climate. By the late 1960s, it was confirmed that the concentration of carbon dioxide in the atmosphere was rising, and that human activities were largely responsible. By using increasing amounts of fossil fuels and by burning off the world's forests, we were releasing trapped carbon into the atmosphere as carbon dioxide.

The task of predicting future climate change is extremely complex. As early as 1971, the report of the Study of Man's Impact on the Climate (SMIC) presented some preliminary model calculations. It estimated that the annual global mean temperature would rise by some 0.5°C by the turn of the century and by some 2°C by about 2030, when the concentration of carbon dioxide in the atmosphere would be twice its pre-industrial level of about 280 parts per million.

Uncertainties over future energy and fossil fuel demand have made it difficult to predict the pace of global warming. The oil crises of the 1970s, for example, forced scenarios of future demand downwards. A conference at Villach in 1980 estimated that in 2025 the concentration of atmospheric carbon dioxide would be about 450 parts per million and that it would take almost 100 years to double pre-industrial levels – a very different timeframe from the one outlined in 1971 at the high noon of the oil bonanza.

Further research brought us full circle. The discovery that other trace gases contribute to global warming has brought many scientists back to a date not far from the one spelled out in the SMIC report.

A stepwise investigation of the carbon dioxide problem was initiated by UNEP, WMO and the International Council of Scientific Unions (ICSU) in 1982. Its results were discussed at a meeting held in Villach in 1985. A number of salient points emerged.

First, it was clear that the concentration of carbon dioxide in the atmosphere was climbing. Although emissions caused by deforestation and changes in land use contributed to the rate of increase, they were not expected in themselves to cause significant change in climate.

Second, other trace gases in the atmosphere – in particular methane, nitrous oxides and other oxides of nitrogen, and chlorofluorocarbons (CFCs) – had similar effects to carbon dioxide. As their levels were also increasing, their effect must be added to carbon dioxide's. This meant that the equivalent to a doubling of pre-industrial levels of carbon dioxide could occur as early as 2030, rather than after 2050, as suggested by studies which only took carbon dioxide into account. Trace gases seemed to be playing a much larger role in bringing about a greenhouse effect than had been expected.

There was almost unanimous agreement that the global average surface temperature would rise in response to a doubling of the greenhouse effect. Discrepancies between the results produced by different modelling approaches were insignificant. Doubts as to the effect of greenhouse gases on global climate could be laid aside.

At Villach, I pointed out that the greenhouse phenomenon was not simply an issue for the North. There was increasing evidence that a number of developing countries were likely to be major contributors to climatic warming in the early decades of the next century. Many developing countries would certainly be affected by its results.

Any agenda for action, I stressed, must examine in detail the options before the world's decision makers. Governments and industry must discuss the feasibility of reducing emissions of greenhouse gases, the industries involved must be identified and strategies investigated. There was a need for a wider debate on the costs and benefits of a radical shift away from fossil fuel consumption – and the political and economic costs of inaction should also be assessed. Most important of all, we must launch serious discussions on what socio-economic impacts we should be prepared to live with and develop clear options for response.

I urged a commitment to further scientific and technical research. Climate models and other projections needed to be improved greatly if they were to be a credible foundation for political action. And I asked what the greenhouse effect would mean for the person on the street in 20 or 30 years' time. The public must be informed about its social and economic consequences.

Finally, I called for an international committee to encourage and review monitoring and research. In 1988, WMO and UNEP set up the Intergovernmental Panel on Climate Change (IPCC). Its aims were to assess scientific information on the various components of climate change, to examine the environmental and socio-economic impacts of climate change and to identify realistic policy responses.

IPCC's task has been amongst the most daunting and intensive in the history of science. Over 1,000 scientists from developed and developing countries pulled together, united in a single cause – to sharpen understanding of global warming and to chart effective, equitable global responses.

The reports of the IPCC Working Groups were published in time for the Second World Climate Conference in Geneva in November 1990. Their verdict was clear. Scientific evidence indicates that we face warming trends faster than at any time in the last 10,000 years.

If human activity continues to overstrain our living biosphere in this way, average temperatures may rise by about 0.3°C each decade and by about 3°C before the end of the 21st century.

«Detailed analysis of temperature records of the past 100 years indicates that global mean temperature has risen by 0.3–0.6°C.

Much of the warming since 1900 has been concentrated in two periods, the first between about 1910 and 1940 and the other since 1975; the five warmest years on record have all been in the 1980s. The size of the warming over the last century is broadly consistent with the predictions of climate models, but is also of the same magnitude as natural climate variability. »

M. K. Tolba, *Saving Our Planet*, Chapman & Hall 1992

The IPCC findings confirm that this warming could lead to a 20 centimetre rise in sea levels by 2030, and a 65 centimetre rise by 2100. Should that occur, coral islands and low lying coastal areas face catastrophe, unless they are defended at great cost. If only 1 per cent of the 6 billion people alive in 2000 are affected, there will be 60 million environmental victims and refugees.

The reports carry sobering analyses of the other impacts of global warming, including the possibility of abrupt changes in climatic patterns. Weather, pest and agricultural disease distribution may change. Forest deaths may increase. Biological diversity could be further impoverished. Unpredictable climate could aggravate the challenge of securing food supplies for skyrocketing populations in poor and marginal lands. The impacts will be felt most severely in regions that are already under stress, mainly in developing countries.

Global warming and the forces driving it are now broadly understood. A clear scientific consensus has emerged on the range of warming which can be expected during the 21st century, in spite of uncertainties about its precise regional distribution and its environmental consequences.

On the basis of current scientific findings, the world community has two options. The first is to consider the issue academic and to let things go on as at present. In this case, the world will suddenly have to adapt its socio-economic structure to the changing climate and will face potentially catastrophic consequences. This option is clearly unviable.

The second option is to anticipate and take immediate measures to slow down the build-up of greenhouse gases in the atmosphere – thus minimizing the warming and its potential undesirable consequences.

At the World Conference on Climate Change in Cairo in December 1989, I recommended five steps which the international community should be taking.

First, greenhouse gas emissions should be stabilized by the year 2000 and cut by 20 per cent by 2010. These reductions must be achieved without stunting economic growth in developing nations, where it is so desperately needed to raise the living standards of the poor. The best prospect of achieving these targets is through increased energy efficiency.

Second, we must prepare to adapt to climate change. For instance, we must plan for sea level rise. This will involve building coastal barriers. The costs will be huge – the Netherlands spent \$15 billion over 30 years and plans to spend another \$10 billion by the year 2000 – but they need not bankrupt nations.

Third, unless developing nations are made privy to technological know-how and have easy access to plant and equipment through subsidies, preferential loans or

other means, we can forget about making any realistic preparations for an overheated world. Everything the developed nations do will be negated if even a handful of industrializing countries press ahead with their fossil fuel and CFC based development plans, using outmoded and outdated technologies. To facilitate increased technology transfer from North to South, we must find means of compensating the private sector for forgoing its proprietary rights.

Fourth, a massive reforestation effort must begin in earnest. Indonesia and Brazil, for example, contribute seven times more carbon dioxide to the atmosphere through forest burning than through fossil fuel combustion. In Côte d'Ivoire the ratio is 100:1.

Most important of all, we cannot shy away from the fact that preparing for climate change is going to cost billions. This money must be channelled through a multilateral mechanism immune to political manipulation.

In 1990, the Second World Climate Conference urged nations to take steps towards reducing sources and increasing sinks of greenhouse gases, and towards a global convention on climate change. 'The long term goal,' it concluded, 'should be to halt the build-up of greenhouse gases at a level that minimizes risks to society and natural ecosystems.' It added that 'technically feasible and cost effective opportunities exist to reduce carbon dioxide emissions in all countries'.

Although a number of international legal mechanisms existed which had a bearing on climate change, they were inadequate. The conference's call for a convention echoed the international consensus which had emerged at the 44th session of the United Nations General Assembly in 1989. The IPCC suggested that this framework convention should articulate a multilateral strategy for controlling greenhouse gases and at the same time encourage unilateral action by the largest emitters and specific national commitments.

Preparing the convention has proved to be a formidable task. According to the World Energy Conference of 1989, global energy consumption will rise by 50 to 75 per cent between 1985 and 2020. The developing countries will account for up to 75 per cent of this growth.

This should not come as a surprise. China, Brazil and India alone will have a combined population of 3.5 billion by the middle of next century. They are pursuing ambitious industrialization strategies which will be driven by fossil fuels. China, for instance, has one of the biggest coal reserves in the world. Today she contributes

only 9 per cent of global carbon dioxide emissions, but her national strategy calls for a ninefold increase in energy use by the year 2030.

In the North, the energy and industrial sectors will face draconian action. Coal is likely to be the first target – and the most drastically affected. A consensus is taking shape in western economies which maintains that market price mechanisms should be adjusted – through taxes and fees – to take account of the full environmental and social costs of goods and services. Under such a price adjustment, coal prices could rise by \$30 a tonne.

A report of the US Environmental Protection Agency in 1989 reviewed pricing strategies, including emission fees related to the carbon content of different fossil fuels. These ranged from a 28 to 40 per cent price rise for coal, 20 to 30 per cent for oil and 13 to 20 per cent for natural gas.

Such fees and taxes would tackle the problem by dampening the demand for coal.

The alternative – removing carbon dioxide from stack gases – is expensive, both in terms of energy and capital, and remains impractical. A UNEP-commissioned report estimated that, even before disposal costs are factored in, halving the carbon dioxide emitted by US power stations would cost \$4 billion a year.

Removing sulphur dioxide and carbon dioxide would double electricity bills. Capital costs in the US alone would approach \$1 trillion.

It is hardly surprising that analysts are emphasizing a shift from coal to oil to natural gas, in that order. In many scenarios to limit greenhouse gases, coal ideally disappears.

Agreement is strong on the need for conservation and reforestation to cut down carbon dioxide emissions from forest burning and to increase natural carbon sinks. In November 1989, in Noordwijk, 60 Ministers pledged dramatic increases in afforestation efforts in both North and South. The consensus was prompted by the threat to the climate, but made possible by the fact that forest conservation makes sound economic and environmental sense.

Looking at the overall picture, it is clear that the challenge of dealing with climate change exists on three fronts: the industrialized nations, developing countries and the countries of East and Central Europe.

Industrialized nations must cut back on their carbon emissions. Some reports have

shown that the US – responsible for about 25 per cent of total carbon emissions – is one of the least efficient users of energy. Cost effective, commercially viable technologies exist right now which could significantly improve performance and lower these energy needs.

Developing countries – particularly the newly industrializing nations – must not embark on a path that is carbon and pollution intensive. Developed countries must provide developing countries with the financial and technological capability to leapfrog inefficient technologies.

The countries of East and Central Europe are already saddled with outmoded smokestack industries. Only now do we realize how great a task OECD nations face in helping these countries comply with the new targets. It is crucial that this aid is not at the expense of the needs of the global South.

Trillions of dollars may be needed to even approach the goal of stabilizing the atmosphere. Yet the cost of inaction will be much higher – it could quite literally cost us the Earth.

Action will be less painful if we put real effort into developing better technologies. Over the next 10 to 15 years, much could be done at negligible cost to reduce greenhouse gas emissions, using technologies which are already available. Some analysts argue that initial steps would be of actual economic benefit. Longer term, more extensive abatement measures will be more expensive and could cost between 1 and 2 per cent of global GDP.

A United Nations Framework Convention on Climate Change was signed during the UN Conference on Environment and Development in Rio de Janeiro in June 1992. Its ultimate aim is to stabilize greenhouse gases in the atmosphere at a level that will prevent dangerous changes in the climate system. As some degree of climate change is now inevitable, this must be achieved within a timeframe which will allow ecosystems to adapt naturally, so that food production is not threatened and sustainable economic development can proceed.

MARINE POLLUTION

From assessment to action

Oceans cover 71 per cent of the world's surface. Through their interactions with the atmosphere, lithosphere and biosphere (in what is known as the geochemical cycles), they have played a major role in shaping the conditions which have made life on Earth possible.

In addition to providing the habitat for a vast array of plants and animals, the oceans also supply people with food, energy and mineral resources.

The vastness of the oceans has encouraged the myth that they have an infinite capacity to dilute and can therefore be seen as a huge garbage dump for all man's wastes. This myth has been exploded. Pollution is becoming a serious problem, especially in coastal areas and enclosed and semi-enclosed seas.

Keeping these waters productive is a vital part of any sustainable development strategy. Many of us depend on the health of the seas we share. Seven out of 10 people around the globe live within 80 kilometres of the coast. Almost half the cities with over a million inhabitants lie on tidal river mouths.

One reason for the popularity of coastal zones is obvious: they provide all but 10 per cent of the world's fishing catch. In many countries, fish is the major source of animal protein, accounting for 55 per cent in Asia, for example.

Mudflats, coral reefs, shallows, estuaries, caves, mangroves and beaches are the home of most marine life. A large majority of the 20,000 known varieties of fish, 30,000 species of mollusc and almost all the crustaceans are found in coastal zones. Apart from ourselves, many birds and animals rely on the sea's coastal harvest.

Coastal zones are precisely where human beings put most pressure on the marine environment. We use them for our settlements, as our food store, as our playground and as our rubbish dump.

Something less than 10 per cent of all the material entering these waters reaches the open ocean. The rest remains in the coastal sediment. Sludge from domestic sewers has almost completely stifled once productive shellfish beds near several North

American cities. In Indonesia, dramatic declines in shrimp harvests have been recorded in areas cleared of mangrove.

Some 6.5 million tonnes of litter find their way into the sea each year. In the past, much of this disintegrated quickly, but resistant synthetic substances have now replaced many natural, more degradable materials. Plastics, for example, persist for up to 50 years and, because they are usually buoyant, are widely distributed by ocean currents and the wind. Most beaches near population centres are littered with plastic waste washed up from the sea – dumped by rivers, ships, outfalls or by illegal refuse operators – or left behind by beach users.

Oil is another important source of pollution. It was reckoned in 1985 that 22.3 million barrels (3.2 million tonnes) of oil entered the marine environment every year. Of this, municipal wastes and runoff accounted for 8.1 million barrels and maritime vessels for about 10.1 million barrels.

The last figure has fallen considerably in recent years. In 1989, oil pollution from sea traffic was down to about 4 million barrels, of which 20 per cent came from tanker accidents. This improvement stems in large part from MARPOL 73/78 – the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 – which entered into force in 1983. The Convention now applies to more than 85 per cent of the world fleet of merchant ships.

Most wastes, once introduced into the sea, cannot be removed. Their fate is determined by their chemical composition, their rate of decomposition and by the physical transport processes of the waters which receive them. Non-degradable wastes may travel long distances.

On a world scale, the main risk to human health associated with marine pollution stems from domestic sewage discharged into coastal waters. Epidemiological studies have proved that people who swim in sewage polluted sea water have an above normal incidence of gastric disorders. Ear, respiratory and skin infections may also result. Eating contaminated seafood is firmly linked to serious illness, including viral hepatitis and cholera. Many countries (eg France, Greece, Italy and the USA) have had to close beaches temporarily because their water quality was not acceptable for bathing.

The challenge facing the world community is how to strike a balance between development and the preservation of the coastal environment.

« Red tides caused by algal blooms are annual events in many parts of the world. Japan's Inland Sea is affected by some 200 red tides each year. Blooms of toxic species occurred in the North Sea with increasing frequency in the 1970s and 1980s. In 1988, a massive bloom occurred in the seas around southern Scandinavia, damaging marine life in some seas and some fish farms along the coast of Norway.

Although unusual occurrences of algal blooms have been attributed to a combination of many factors, especially to disturbances in the marine ecological balance caused by climatic factors, considerable evidence suggests that the increased incidence of blooms is related to the nutrient enrichment of coastal waters and inland seas on a global scale. »

M. K. Tolba, *Saving Our Planet*

What should we do with the wastes from our factories, homes and ships? They have to go somewhere. Yet we have to consider our neighbours as well as ourselves. Traces of the pesticide DDT have been found in Antarctic penguins and seals, far from anywhere it has been used. So far there are no reports of harmful effects on humans. By contrast, scores of people in the Japanese village of Minamata died when they ate fish contaminated by wastes from a nearby industrial plant.

Coastal ecosystems intermesh with terrestrial and open ocean systems to form a complex whole. The tides and currents that make coastal waters so productive also render them exceptionally vulnerable to pollution. Damage one part of the system and a chain reaction begins. Deforestation in watersheds hundreds of kilometres inland can result in silt choked harbours and coral reefs.

If we want to live in balance with the environment, we first need to know how much pollution we produce and how toxic it is. We also need to learn how to make sustained use of the resources of the environment and how best to legislate to protect them. Any rational conservation programme must provide both for scientific assessment and for environmental management. This can only be effectively achieved through international cooperation.

Environmental problems rarely affect one nation alone – particularly when it comes to coastal areas and the marine environment. Each country's pollution, whether

onshore or offshore, can degrade the environment of neighbouring states. Within a region, fishing grounds are normally shared by several nations.

Problems caused by oil spills, pollution from the land or the pressure of human settlements on animal habitats are often specific to a region. Protecting the coastal environment and the sea's resources therefore depends on regional cooperation.

Historically, international marine agreements regulated navigation and fishing. It has only recently been recognized that the world's oceans should be regulated and protected as a natural resource. This important switch from a 'user oriented' to a 'resource oriented' approach has become most marked in the last two decades. Most legal regimes adopted since 1971 have encompassed the protection, conservation and management of the marine and coastal environment and their resources.

With UNEP acting as catalyst and coordinator, the Regional Seas Programme was launched in the mid-1970s. Its basic strategy has been to tackle the causes as well as the consequences of environmental damage in coastal areas. In each region, this strategy encompasses an action plan setting out activities for research and cooperation, including assessment and management; a legally binding convention embodying general commitments; technical and specific protocols on such issues as dumping, pollution emergencies, land based pollution sources, and conservation; and financial and institutional arrangements that provide the back-up for these components.

The forerunner was the Mediterranean. A miniature ocean, bordered by 120 cities with a population of at least 100 million, its virtually enclosed waters have been the well beaten crossroads of European, Asian and African civilization for at least 4,000 years of recorded history. In the early 1970s, pollution led many to fear the sea might die. Once a symbol of the sea's beneficial impact on man, it became a symbol of man's destructive impact on the sea.

In February 1975, against a background of gathering international concern, UNEP helped the countries of the Mediterranean region to adopt an action plan (MAP) for the protection and development of their common sea. In 1976 the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution, plus two protocols, was signed. In the same year, a regional oil combating centre was established in Malta.

In 1979, the Blue Plan for the long term management of the Mediterranean was launched as part of the socio-economic component of the MAP. Its aim was to

BOX 4.1 THE 10 PRIORITIES OF THE GENOA MINISTERIAL DECLARATION (1985)

The bordering states will attach priority to:

1. establishment of reception facilities for dirty ballast waters and other oily residues in parts of the Mediterranean;
2. establishment as a matter of priority of sewage treatment plants in all cities around the Mediterranean with more than 100,000 inhabitants and appropriate outfalls and/or appropriate treatment plants for all towns with more than 10,000 inhabitants;
3. applying environmental impact assessment as an important tool to ensure proper development activities;
4. cooperation to improve the safety of maritime navigation and to reduce substantially the risk of transport of dangerous toxic substances likely to affect the coastal areas or to induce marine pollution;
5. protection of the endangered marine species (eg the monk seal and the Mediterranean turtle);
6. concrete measures to achieve substantial reduction in industrial pollution and disposal of solid waste in the Mediterranean;
7. identification and protection of at least 100 historic sites of common interest;
8. identification and protection of at least 50 new marine and coastal sites and reserves of Mediterranean interest;
9. intensification of effective measures to prevent and combat forest fires, soil loss and desertification;
10. substantial reduction in air pollution, which adversely affects coastal areas and the marine environment, with the potential danger of acid rains.

integrate development plans with environmental protection. In 1980, the Mediterranean states adopted a protocol which identified measures to control land based pollution of the sea from municipal sewage, industrial wastes and agricultural chemicals. Two years later, they approved a further protocol to protect endangered

species of fauna and flora, as well as critical habitats. In 1985 in Genoa, the Mediterranean countries established 10 priority targets for the decade 1985-1995 (see Box 4.1).

What happened in the Mediterranean had a significance beyond its shores. As the programme evolved, we were able to enlarge our understanding of the role of environment in the overall development process. And we saw that nations, developed and developing, were prepared to put aside their political differences to cooperate in an endeavour to protect their shared environment.

Action plans have now been adopted in the Kuwait region, the wider Caribbean, West and Central Africa, East Africa, the south-east Pacific, the Red Sea and the Gulf of Aden, the South Pacific and in East Asia. Other action plans are at different stages of development. All in all, through the Regional Seas Programme, some 130 countries, 16 UN agencies and over 40 other international and regional organizations are working with UNEP to improve the marine environment and make better use of its resources.

In spite of these efforts, progress has been rather slow, especially in developing regions. Most developing countries still do not have the capacity to adequately assess their marine and coastal problems and manage their resources rationally. Weak institutional structures hamper their participation in international efforts; lack of resources make it difficult to respond rapidly to marine accidents and to combat ensuing environmental threats. Without the necessary material resources and trained personnel, regional rapid-response agreements are of limited use. The 1990 International Convention on Oil Pollution Preparedness, Response and Cooperation, which contains a mandatory requirement for oil pollution emergency plans, is one attempt to improve this situation.

Strong coordinated national and international action should be taken now to prevent the rapid deterioration of the marine environment. At the national level in particular, there must be concerted efforts to reduce discharges into the sea and to manage coastal areas in a rational and environmentally sound way.

FRESHWATER RESOURCES **Making every drop count**

When the pre-Socratic scientific philosophers of ancient Greece listed the four elements – water, earth, air and fire – they hit on the four basic components which enter into all our concerns for the human environment – water, land, air and energy.

Water problems pervade so many of our environmental concerns. In theory, there is enough freshwater on Earth to meet increasing human needs. But in practice this may not be the case – for two reasons.

First, sources of water are unfairly distributed among people and countries. Some communities live where regular rainfall gives them an ample surplus at present. Others have far more water than they want or need, but not necessarily in the right place or at the right time. Still others have barely enough. Drought is perennial through the wide belt of arid lands.

Second, man has modified water circulation and quality both directly – by over-exploitation, wastewater disposal, river regulation, for instance – and indirectly – by using the land in ways which change vegetation and soil cover, thus affecting the hydrological cycle.

In other words, good quality freshwater is becoming more and more scarce. A decline in the quality of river and lake water has long been observed. With growing

«Worldwide the pressures on surface and groundwater supplies are increasing rapidly, exponentially in some cases. Water use in the world increased dramatically from about 1,360 cubic kilometres in 1950 to 4,130 cubic kilometres in 1990 and is expected to reach about 5,190 cubic kilometres by 2000. Although the uses to which water is put vary from country to country, agriculture is the main drain on the water supply. Averaged globally, 69 per cent of water withdrawn goes for that purpose, 23 per cent for industry and 8 per cent for domestic purposes.»

M. K. Tolba, *Saving Our Planet*

industrialization, sewage pollution has been joined by industrial wastes and urban and agricultural runoff.

Underdevelopment may force people to overuse water resources. But I fail to understand the needless pollution of precious water systems. We abuse and often destroy the very environmental resources upon which our wellbeing depends. The near destruction of Lake Erie in North America by industrial pollution, the poisoning of over 20,000 lakes in Scandinavia and Canada by acid rain, the siltation and eutrophication (overenrichment) of thousands of lakes in developing countries by imprudent development and sanitation practices – these cases merely hint at the extent of the problem.

The damage may even be deliberate. Lakes near industrial parks may be sacrificed in the name of economic development. Traditional cost-benefit judgements may be unwise, as in decisions to avoid the expense of pollution control by allowing discharges of non-degradable toxic chemicals. Sometimes, people just do not care.

Many of the world's freshwater resources are shared by two or more states. At least 214 river basins are multinational; 155 are shared between two countries, 36 among three, 23 among four to 12. Over a third of the world's population lives in international river basins, while 75 per cent or more of the area of some 50 countries lies within them.

The joint use of international watercourses has always depended on cooperation between the countries along their banks, regulated in some cases by international treaties and organizations. Historically, these treaties dealt with the allocation of water shares, regulation of navigation and fishing, and construction of barrages and other public works.

Only recently – especially since the early 1970s – have some of these treaties been revised to reflect growing concern about pollution. For example, the Great Lakes Water Quality Agreements of 1972 and 1978 focused, respectively, on pollution from traditional sources, such as municipal sewers, that were causing severe eutrophication, and on toxic pollutants. Since 1980, countries along the Rhine have undertaken a joint programme for the rehabilitation of its waters and the management of its groundwater aquifer.

The shortage of water in some regions raises the possibility of conflicts between nations over shared rivers, lakes and aquifers. 'By the year 2000, water – not oil –

will be the dominant resource issue of the Middle East,' states a report published by Washington's Center for Strategic and International Studies. It adds, 'If present consumption patterns continue, emerging water shortages, combined with a deterioration in water quality, will lead to more desperate competition and conflict.'

International tensions have already arisen over the sharing of international water systems, acidic deposition, aquatic resources and the spillage of hazardous materials. During the last two decades conflicts have emerged over the development of international rivers. The USA and Mexico have clashed over the Colorado; Iraq, Syria and Turkey over the Euphrates; India and Pakistan over the Indus; Israel and Jordan over the Jordan and Brazil and Argentina over the Plate.

As populations rise, so will the scope for conflict. By the year 2000, the Ganges Basin alone may have to support some 500 million people. Tensions could be averted by creating opportunities for mutual cooperation, dialogue, and confidence building among rivals who otherwise know little about each other. UNEP's experiences show that international concern for environmental issues can rise above political and economic conflicts.

Since early times, man has built dams and reservoirs to control floods and to store water for use as the need arises. Hundreds of thousands of dams and reservoirs have been built worldwide, but only a few hundred large multi-purpose dams (for water management and electricity generation) have been built in the present century. Between 1950 and 1986 about 36,240 dams higher than 15 metres were constructed. Of these only about 1 per cent were over 100 metres high; 79 per cent were under 30 metres. About half of these dams were constructed in China alone.

These dams have provided benefits, but they have not been without environmental cost. The past two decades have witnessed wide discussions about the costs and benefits of large dams, such as the Aswan High Dam and others.

New and more comprehensive approaches to water management are needed to enhance socio-economic and environmental development in international basins. The Environmentally Sound Management of Inland Waters (EMINWA) programme, launched by UNEP in 1986, is one such approach.

The EMINWA programme is designed to help governments to integrate environmental considerations into the management and development of inland water resources. It aims to reconcile conflicting interests and to ensure regional

development which is in harmony with the water-related environment throughout entire systems.

Within the framework of EMINWA, the Zambezi Action Plan was adopted in 1987. Eight countries (Angola, Botswana, Malawi, Mozambique, Namibia, United Republic of Tanzania, Zambia and Zimbabwe) are taking part. Plans for other regions – including the Lake Chad basin and the Nile river basin – are in different stages of development.

The issue of climate change – both recent fluctuations in the sub-Saharan countries and the global warming expected in the next century – also complicates water management and planning.

Recent studies of the Sudano-Sahelian region of Africa show that rainfall has been declining continuously over the last 20 years. This reduction has been most significant in Senegal, followed by Mali, Burkina Faso and Niger.

For agriculture, it is not only the total annual rainfall that matters, but when and where it falls. Studies indicate that African rainy seasons have been shorter during recent years. Monthly analyses of rainfall show that the most marked decline has been in August, which is an important month for rainfed agriculture.

Streamflow conditions are vital for both large and small scale irrigation systems. The average annual water yield of all the rivers reaching the Sahel declined by some 25 per cent between 1968 and 1983 – a deficit equivalent to three times the capacity of the Manatali Dam in the Upper Senegal river. Between 1965 and 1983 in places like Maradi, Niger, the annual total flow never once reached the long term average for 1931 to 1960.

These uncertainties complicate not only the operation of existing water resource systems, but also the planning of new ones.

The changes in rainfall likely to be caused by global warming add even more uncertainties. Current climatic models predict that the global mean temperature may rise by between 1.5°C and 4.5°C over the next century. This will change rainfall patterns, but we cannot reliably predict where or how. Yet this information is essential for water management and planning.

There is no doubt in my mind that future human welfare – even survival – depends on our developing new planning methods and management techniques which can cope

with increasing uncertainties and risks. It will not be easy to find solutions. But this is a challenge that scientists must overcome during the next couple of decades.

The possibility of climate change faces water planners with a whole range of new factors and must force them to think in longer timeframes. Changes in evapotranspiration – including greater air humidity – and increased cloudiness could destabilize water balances in basins. The risks of mega-dams in uncertain climate conditions must be considered. So must the benefits of smaller, local projects – they may prove an interim solution, until more is known about regional impacts.

Climate change could make the processes of erosion and sedimentation more unstable; alter the biochemical oxygen demand in coastal areas; and cause saltwater to intrude on freshwater resources. Rising sea levels could disrupt city drainage and sewage treatment systems. Climate change could also affect the lithosphere (the Earth's crust), with profound impacts on groundwater aquifers, soil moisture, freshwater supplies and irrigation systems. These are sweeping challenges. The proven assumptions of water management strategies may be entirely ineffective in new climatic regimes.

Another major issue is the availability of clean water. The United Nations Water Conference at Mar del Plata in 1977 led to the 1980s being declared the International Drinking Water Supply and Sanitation Decade (IDWSSD). It aimed, ambitiously, to provide clean water and appropriate sanitation for all by the end of 1990. Conservative estimates set the cost at some \$300 billion.

Although the targets of the IDWSSD were not met, there were major achievements. Between 1970 and 1990 the percentage of people in developing countries with access to clean water increased: from 67 per cent to 82 per cent in urban areas, and – dramatically – from 14 per cent to 63 per cent in rural areas. Although access to sanitation facilities barely improved in urban areas, in the countryside it rose from 11 per cent in 1970 to 49 per cent in 1990 (see Box 5.1).

The slow progress, particularly in urban areas, has been attributed to several factors, including population growth, rural-urban migration, the unfavourable world economic situation and the debt burden, which has been a major obstacle to investment in infrastructure projects.

As sewage treatment works have been built in the cities of developing countries, large quantities of treated wastewater have become available as an additional

BOX 5.1 IDWSSD AND BEYOND

Between 1981 and 1990

* About 1,348 million people in developing countries were provided with a safe drinking water supply (368 million in urban areas and 980 million in rural areas).

* About 748 million people were provided with suitable sanitation services (314 million in urban areas and 434 million in rural areas).

* Overall, the number of people without safe water fell from 1,825 million to 1,232 million, while the number of people without suitable sanitation remained virtually the same.

At the rate of progress achieved during the decade, we will not reach the ultimate goal of services for all by the end of the century.

At this pace, the number of people without safe water will fall to around 767 million by the year 2000, due to significant improvements in rural areas. Sixteen per cent of the population of the developing countries will have no access to safe water, as opposed to 31 per cent in 1990.

The number without sanitation will rise to around 1,880 million, although the percentage unserved will decrease from 43 to 38 per cent, due to a small improvement in services in rural areas.

This low level of services will have consequences for health and the environment which are incompatible with sustainable development.

source of water. Wastewater can be used in agriculture, inland fisheries, industry or to recharge groundwater. These options increase with the extent of treatment and reliable quality control. By reusing wastewater for appropriate purposes, higher quality water can be released for others.

This creation of useable wastewater could be crucial in arid countries. Jordan, for example, has an extensive sewage treatment plant construction programme which is expected to produce some 650 million cubic metres of wastewater per year by 1995

– approximately 15 per cent of Jordan’s total current water demand. This could make the difference between crises and development.

Only 6 per cent of the water on Earth is freshwater – and only 1 per cent of that is easily available to humanity. The rest is buried deep underground or frozen up in icecaps and glaciers. Much depends on how we steward, share and conserve this immensely precious resource.

LAND DEGRADATION

Desertification can be stemmed

Human activities have radically reshaped the world's natural land cover. Indiscriminate destruction of forests and woodlands, overgrazing by burgeoning herds of livestock and improper management of agricultural land have all led to extensive degradation.

The recent Global Assessment of Soil Degradation, carried out by the International Soil Reference and Information Centre (ISRIC) in the Netherlands, estimates that 15 per cent of the Earth's land area has been degraded to some degree.

Of this degraded land, over a half has been eroded by water, over a quarter by the wind, over a tenth by chemicals (causing the loss of nutrients, salinization, pollution and acidification) and 4.2 per cent by compaction, waterlogging and subsidence. The main causes are overgrazing (responsible for 34.5 per cent of the degraded area), deforestation (29.5 per cent), farming (28.1 per cent), overexploitation (7 per cent), and bio-industrial activities such as waste accumulation, excessive manuring and the use of agrochemicals (1.2 per cent).

Drylands (arid, semi-arid and dry subhumid areas) cover nearly half the land surface of the Earth – 62 per cent of the world's irrigated land, 36 per cent of its rainfed cropland and 68 per cent of its rangelands. In these areas, land degradation caused mainly by human activities is known as desertification.

Drylands today are under unprecedented stress. Three quarters have been affected, to some degree, by desertification driven by soaring numbers of people and livestock, chronic drought, bad land use practices, heavy debt burdens and the harsh terms of international trade.

An assessment published by UNEP in 1991 found that 30 per cent of irrigated drylands (some 43 million hectares) were affected, at least moderately, by waterlogging, salinization, alkalization and other processes of degradation. It has been estimated that the world loses an area of irrigated land nearly the size of Swaziland every year. Between two thirds and four fifths of this is dryland.

Nearly 216 million hectares of dry rainfed croplands (47 per cent) are affected by

water and wind erosion, nutrient depletion and physical deterioration. An area of rainfed cropland about the size of Sierra Leone is lost every year, of which some half is dryland.

Nearly three quarters of all rangelands in drylands (some 3.3 billion hectares) are affected, mainly by loss of vegetation and by erosion. All in all, some 70 per cent of all agriculturally used drylands suffer from varying degrees of desertification.

The Sahelian drought of 1968-73, with its great loss of life and agricultural production, stimulated international concern about desertification. Ninety-four countries and various international organizations sent representatives to the United Nations Conference on Desertification (UNCOD) in Nairobi in 1977.

Scientific evidence presented at UNCOD identified desertification as a serious and accelerating threat to human welfare, at a time when enormous increases in food production were needed. The problem was urgent, because land reclamation costs rise steeply as degradation proceeds. Eventually reclamation becomes economically impractical.

The conference pointed to man, rather than climate, as the chief agent of desertification. As people sought to wrest a living from fragile ecosystems, under harsh and unpredictable climatic conditions and a variety of social and economic pressures, they misused or overused the land. Too frequently they acted in this way because no other alternatives were apparent to them.

The experts asserted that the knowledge and technology existed to halt desertification and, in many instances, to reverse the process and restore degraded land. The key was proper land use – not only in farming, ranching and forestry, but also in tourism, recreation, mining, industry and human settlements.

Finally, they concluded, desertification was a human problem as well as a question of natural resources. If man was its agent, he was also its victim. Land degradation was invariably accompanied by the degradation of human wellbeing and social prospects. Efforts to combat desertification must centre on human welfare and contribute to the development and prosperity of the communities affected. Priority might be given to the most vulnerable nations and communities rather than to the most vulnerable land, although, of course, these categories often coincided.

At UNCOD the world community spelled out three basic goals: to stop the process of

«While people are the main agents of land degradation and desertification, they are also the victims. Throughout the Third World, land degradation has been the main factor in the migration of subsistence farmers into the slums and shantytowns of major cities, producing desperate populations vulnerable to disease and natural disasters and prone to participate in crime and civil strife. Such an exodus from rural to urban areas has exacerbated the already dire urban problems in many developing countries. At the same time, it has delayed efforts to rehabilitate and develop rural areas through lack of manpower and increased neglect of the land. The effects of land degradation and desertification are compounded by recurrent droughts. The mass exodus that has been taking place in Africa since the late 1970s is a vivid illustration of the plight of people facing such intolerable environmental conditions. At the peak of the crisis in 1984 and 1985, an estimated 30 to 35 million people in 21 African countries were seriously affected, of whom about 10 million were displaced and became known as 'environmental refugees'. »

M. K. Tolba, *Saving Our Planet*

desertification, to rehabilitate affected land and to prevent future desertification through proper land management. These came together in a 28 point Plan of Action to Combat Desertification (PACD), which outlined a three step approach.

First, the scale of the problem must be defined. This would involve strengthening or establishing national bodies for assessment and monitoring; determining the criteria for identifying and assessing desertification and its causes; and, on that basis, assessing the problem and determining what land uses, where, led to desertification.

Second, if a significant problem were found to exist, combat programmes should be drawn up and put into action and a system set up to monitor the spread of desertification.

Finally, where remedial programmes had already begun, their progress should be monitored and their usefulness assessed, and the resulting information disseminated.

The Plan of Action was unanimously adopted by the General Assembly of the United

Nations in December 1977. Why has so little come of it? Why were the funds just not there?

I believe that decision makers misunderstand the true cost-benefit relationship of desertification control programmes, and that this has hindered implementation of the PACD. It is clear that adequate funds will not be forthcoming unless the costs and benefits of anti-desertification measures are made explicit.

Implementing the PACD means different things in industrialized countries, which can cope with the problem by themselves, and in developing countries, which need substantial external assistance. In countries like Australia or the USA, development does not depend on drylands. So desertification can be approached from an economic and technical point of view: how to stop land degradation and optimize the economic return from drylands.

By contrast, the development process in most developing countries, and particularly in the Sudano-Sahelian Belt of Africa, relies on the natural resource base. The problem is further complicated by the social systems which interact with dryland resources, requiring a holistic approach. For most countries affected by desertification, the PACD is, in effect, a plan of action for sustained dryland development.

To set this process of sustainable development in motion we must convince the public and their leaders. Decision makers are not for the most part people with a background in the physical or natural sciences. They tend to be economists, lawyers, social scientists, bankers, businessmen, planners and the like. Because of their immediate responsibilities, they do not bear the interests of the next generation in mind when they make decisions. They decide with a view to the next election or to the annual balance of payments or to the next meeting of shareholders.

We have to convince these decision makers that an investment in better arid land management, in desertification control and in other forms of environmental protection pays. And to do this, we must emphasize two crucial interrelationships.

The first is the critical link between the natural world, which includes human society, and development. Conservation and social development must be pursued together as goals of equal importance. Interactions between the forces of social development change. The complex relationships between resources, environment, people and development impel governments to think in terms of trade-offs between alternative courses of action.

The second is the connection between development and economic growth. Our understanding of this relationship has broadened in recent years. Development is no longer seen exclusively as a matter of the rate of national income growth or the rate of capital formation. The new emphasis is on wider and more qualitative aspects, such as income distribution, employment, health, housing, education and so forth.

Applying these principles to arid lands and desertification control, we find ourselves having to address problems that are not primarily scientific, but which have enormous impact on the affected ecosystems.

The issue of land tenure, for instance, goes to the root of the problem. Arable farmers must own their land outright – on an individual or collective basis – before they will devote energy and resources to conserving it.

To combat poor land management, there must be realistic incentives for sustainable land use. In the developed countries, tax incentives and penalties can bring economic interests into line with environmental ones. In the developing world, these methods are less easily applied. Here, governments could reward environmentally sound land use practices – such as terracing and building check dams – with price subsidies for agricultural implements and supplies. Authorities could provide seed, fertilizer, agricultural implements, water pumps and so on free or at discount prices as a reward for applying conservation measures.

Other incentives could include allocating development projects to areas which follow accepted guidelines on good land use, improving extension services and credit schemes, and working within agricultural cooperatives to promote the benefits of sustainable development.

Another option would be 'production mode regulation'. Sensible penalties can be brought to bear on those who unnecessarily degrade their land. In the developing world farmers who misuse the land could be sent to the end of the queue for agricultural credit, whether from central or local authorities or from cooperatives.

Such ideas may cast some light on our lack of success in countering desertification. Desertification control is a multisectoral issue involving a range of scientific disciplines, technical and engineering skills, as well as social and economic management. It is not that we have been concentrating too much on the purely scientific issues, it is that we have not concentrated enough on the social, economic and political aspects.

The social and economic benefits of desertification control are not easily quantified in neo-classical economics. As a result, the wrong development decisions are made. A flawed accounting system encourages planners to liquidate their resources as quickly as possible.

A country that accumulates capital through overgrazing or rapid deforestation erodes the foundations of its prosperity and yet this country is said to be getting wealthy. The country that takes only the 'interest' while leaving its environmental 'capital' intact is branded a bad performer. Resource based accounting requires a broader view of economic systems with an understanding of the role of resources in development.

To achieve the goal of reducing land degradation through dryland development, the strategy of the PACD focuses on three areas: social, economic, cultural and political development with emphasis on such issues as poverty, food, housing, employment, health, education, population pressures and demographic imbalance; conservation of natural resources with emphasis on water, energy, soil, minerals, plant and animal resources in arid, semi-arid and subhumid areas; and environmental control with special emphasis on soil fertility and on preventing soil loss, pollution and deforestation.

It is estimated that desertification today costs the world \$42 billion a year, in terms of on-site income forgone. Indirect off-site and social costs may be two, three or even up to 10 times as high.

In contrast, the cost of halting the spread of desertification and of direct corrective measures in moderately affected areas amounts to \$3.8–11.4 billion a year for a 20 year programme. Of this, \$2.2–6.6 billion a year is needed to finance action in 81 developing countries. Half of this sum, at most, could be raised by the countries themselves, while the other half would need to come through external assistance.

The need is urgent, for both socio-economic and environmental reasons. Desertification is the main cause of the world's loss of productive land. It causes economic instability and political unrest in affected areas and stops countries from achieving sustainable development. It also puts pressures on the economy and stability of societies further away. And it contributes to the loss of global biodiversity, the loss of the biomass and bioproductivity of the planet, and to global climate change.

The cost of addressing desertification is an investment in the future of our planet.

BIOLOGICAL DIVERSITY

Saving what we can, while we can

The Earth's genes, species, and ecosystems are the product of hundreds of millions of years of evolution, and have enabled our species to prosper. Human activities are destroying this biological diversity at a rate which is far more likely to accelerate than to stabilize.

Like other natural resources, the global distribution of living species is not uniform. Abundance generally increases as we move from the poles to the equator. As many species of trees have been found in one 15 hectare area of Borneo rainforest as in the whole of North America. Yet, tropical forests – home to roughly half our planet's inventory of biodiversity – are being destroyed by as much as 17 million hectares a year.

Tropical forests are not the only rich ecosystems. Wetlands, the Mediterranean climate regions of southern Africa, coral reefs and temperate forest zones also abound in biodiversity and are also under severe ecological stress. Eighty per cent of the 23,000 species of plants estimated to occur in South Africa, Lesotho, Swaziland, Namibia and Botswana are unique to the region. This gives the area the highest species richness in the world, nearly twice that of Brazil.

Wetlands provide essential habitats and breeding grounds for many plant and animal species and help to regulate water flows. Yet over half the coastal and freshwater wetlands of the US have been destroyed and many parts of Europe have lost nearly all their natural wetlands. In tropical countries as diverse as Chad, Bangladesh, India and Vietnam 80 to 90 per cent of wetlands have been destroyed.

For 3 billion years, life on Earth has been characterized by ever increasing diversity. Extinction has always been a part of that picture. It is a part of the process of natural selection: the engine of evolution. Over 99 per cent all the species which have ever lived are now extinct. These extinctions have almost always occurred within the context of a general widening of the pool of genetic resources. A species becomes extinct when better adapted competitors rise up to displace it.

Only five, relatively brief, episodes of decline have interrupted the upward march towards ever greater diversity. They marked the end of five geological periods: the Ordovician, the Devonian, the Permian, the Triassic and the Cretaceous. The

extinctions were so extraordinary, and so far reaching in their consequences, that even now they cannot fully be explained.

It is believed by some that the most recent of these obliterations – that which ended the Cretaceous period 60 million years ago and wiped out the dinosaurs – can only have been caused by some extraplanetary phenomenon: the impact of an asteroid, perhaps, or some other event so catastrophic that it led to a rapid change in the surface temperature of our world.

And now – without the aid of extraplanetary intervention – we face a wave of extinctions unmatched in 60 million years, or even worse. If, as has been suggested, up to 25 per cent of the species now living become extinct within a single human lifetime, that would surpass even the late Cretaceous period. Only once in the 3 billion years of life on Earth has greater destruction been seen. According to a report of the National Science Foundation of the United States, 'The rate of extinction over the next few decades is likely to rise to at least 1,000 times the normal rate of extinction.'

The largest, most complex species of animals on our planet face extinction. The holocaust of the African elephant is appalling. In Kenya, it is estimated that two thirds of the 65,000 elephants alive in 1981 have been killed. Based on current rates of decline, some believe Africa's elephants – which numbered 1.4 million in 1979 – will be virtually wiped out by the turn of the century.

Similar fates await the mountain gorilla and the white rhino of Africa, the blue whale of the southern oceans, the giant octopus of the Caribbean, the monk seal of the Mediterranean, the giant panda of China, the polar bear of the Arctic. African rice is nearly extinct in West Africa. It is estimated that three quarters of all vegetable varieties now grown in Europe will vanish in the next decade.

For many animals and plants, the countdown to extinction is quickening. The treadmill of environmental destruction is taking an unimaginable toll. We could be losing 2,000 to 3,000 species a year – or even, according to other estimates, as many as 30,000, almost 100 per day. These species are – or may be – useful sources of food, shelter, medicines and materials. There is evidence that every remaining wilderness area in every temperate region across the globe will soon disappear, except for special reserves.

We lose some species before we even discover them. Not long ago, scientists

BOX 7.1 SOCIO-ECONOMIC BENEFITS OF BIODIVERSITY

- * About 4.5 per cent of the GDP of the USA (some \$87 billion per year) is attributable to the harvest of wild species.
- * In Asia, by the mid-1970s, genetically introduced dwarfism had increased wheat production by \$2 billion and rice production by \$1.5 billion a year.
- * A 'useless' wild wheat plant from Turkey was used to give disease resistance to commercial wheat varieties worth \$50 million a year to the US alone.
- * One gene from a single Ethiopian barley plant now protects California's \$160 million a year barley crop from yellow dwarf virus.
- * An ancient wild relative of corn from Mexico can be crossed with modern varieties, potentially saving the world's farmers \$4.4 billion a year.
- * Worldwide, medicines from wild products are worth some \$40 billion a year.
- * In 1960, a child suffering from leukaemia had only one chance in five of survival. Now the child has four chances in five, due to medicines which contain active substances from the rosy periwinkle, a plant originating in the tropical forests of Madagascar.

believed our planet supported between 3 to 5 million species. Current estimates reach 30 million species or more. Modern scientific methods, coaxing new secrets from the Earth, confirm that she is pregnant with unknown life.

By contrast, our biological inventory – mostly compiled during the century after Darwin's voyage in the *Beagle* – has covered 1.4 to 1.7 million species. We have barely skimmed the surface of nature's miracles. Two decades after man first walked on the moon's surface, a vast uncertainty remains about the secrets hidden on the Earth.

The boundless possibilities of the biological unknown are being decimated at an unrelenting and accelerating pace. Charles Darwin published *The Origin of Species* 130 years ago. If he were writing today, he might entitle his thesis *The Obituary of Species*.

This mass extinction is compounded by the fact that we have embarked on a course of botanical uniformity that increases the risk of diseases and pests. In South East Asia, where once thousands of varieties of rice were used, today 60 per cent of ricelands are sown with only one variety. In India, where as many as 30,000 rice varieties flourished 10 years ago, agronomists estimate that no more than a dozen will dominate three quarters of the land by the turn of the century. Agricultural practices obsessed with cash crops and monocultures are spelling doom for the planet's biological diversity and endangering its genetic pool.

Why have we embarked on this enormous act of destruction? Why have we committed ourselves to what could be an unsustainable food policy? To understand, and to deal with the results, we have to know something of the scope of conservation, the needs and costs of global conservation, and the economic forces that drive monoculture cropping.

First, the scope of conservation. Some 4,500 reserves, covering 485 million hectares worldwide, are biodiversity's main defence. The number of protected areas has nearly doubled in the last 20 years, and the total land area under protection has increased by over 60 per cent. Yet *in situ* conservation areas represent less than 3 per cent of the world's total icefree area. Not enough in themselves, many of these reserves constitute little more than lines on a map, underfunded and understaffed.

An adequate target of parks, reserves, protected landscapes and botanical gardens must be defined – taking into account the needs of local people and providing fair compensation to those who are contributing these areas for the benefit of mankind.

But *in situ* policies by themselves cannot quarantine biological diversity against airborne pollution, ozone layer depletion, coastal and marine pollution, soil degradation, climate change and other environmental problems. *In situ* and *ex situ* conservation strategies that map out concrete goals, targets and timetables should go together. We need to ensure that sizable areas of virgin forest, soil, coastal areas, oceans and other natural resources are conserved. And we need to ensure that threatened species are protected *in situ* or in accessible genebanks.

We must also coordinate *in situ* and *ex situ* conservation plans and targets with action in related areas that affect habitats, ecosystems and biological diversity – such as plans to halt desertification, conserve tropical forests, reduce transboundary air pollution and protect freshwater resources.

Second, the needs and costs of global conservation. Biological diversity has always been viewed as a common heritage, like knowledge. Increased consumption by a few was thought not to reduce its availability to others. Such assumptions, obviously, were inadequate. To correct them, clearly delineated economic incentives for species conservation must be introduced.

The stock of genetic resources represents a vast, untapped reservoir that will no doubt improve agricultural practices, and provide cures to diseases. Advances in medicine, agriculture and industry have often occurred only because of the variety of genetic information. Today, humans use less than one tenth of 1 per cent of all naturally occurring species.

Obviously, when it comes to species with high market values, investment in conservation is no problem. The potential market value of millions of undiscovered species is certainly great, but it is unknown. It nonetheless demands substantially increased investment in conservation.

This means that we must attach a value to species, both known and unknown. Many argue that it is immoral to put a price on nature's creations. That may be partly true. But we have got to adjust economic systems to work for, not against, environmental conservation.

Third, the economic forces that drive monoculture cropping. The penetration of the cash economy into rural areas is still relatively new in many parts of the world. One effect has been to create a vastly expanded cash market in seeds. For 12,000 years – from when the Sumerians first began to sow crops almost up to the present day – farmers have been plant breeders, saving their best seeds for use the following year. Now seeds are a \$93 billion a year corporate business. The millions of plant breeders have dwindled to a small cadre of scientists in the employ of a handful of transnational corporations.

Corporate penetration of the seed market has been facilitated by the legal regime of 'plant breeder rights'. These laws vary from country to country, but are normally an outgrowth of intellectual property rights, allowing corporations to be given legally protected property rights over particular varieties. This legal protection is seen by some as vital for stimulating the burgeoning growth of existing biotechnologies (such as tissue culture) and new techniques (including genetic engineering).

If this system of property rights were extended to the Third World there would be an

irony. Third World countries – where most seed gathering takes place – would find themselves paying dearly for crop varieties bred on the basis of genetic material they themselves had provided.

This is not to say that I am necessarily against this operation of the market. Intellectual property rights can be an important spur to innovation. But if there is going to be a market-based trade in genetic material, then it should be fair: a trade in which not only the innovator is remunerated, at the far end of the process, but also the conserver who has maintained and improved the material over generations and now made it available. The market places a high price on the final value added product, but almost no value at all on the genetic materials that feed into that product: genetic materials that have often been nurtured and improved for generations in the country of origin.

Four kinds of action have been taken by the international community and by governments to promote the conservation and sustainable use of biological diversity: measures to protect particular habitats as National Parks, Biosphere Reserves or other protected areas; measures to protect particular species or groups of species from overexploitation; measures to promote *ex situ* conservation of species in botanic gardens or in genebanks; and measures to curb the pollution of the biosphere.

Genetic conservation has also been addressed. The International Board for Plant Genetic Resources (IBPGR), set up in 1984, has played a role in developing strategies for conserving crop genetic resources and in setting up seedbanks. The Food and Agriculture Organization of the United Nations (FAO) has also been active in this field. The emergence of ‘farmer’s rights’ as a legal counterpoint to ‘breeder’s rights’, has largely grown out of their initiatives.

Economic support has also been developing. Debt-for-nature swaps have been used as a lever in Costa Rica, Ecuador, Bolivia and the Philippines. The Global Environment Facility, set up by the World Bank in cooperation with UNEP and UNDP, has set several hundred million dollars aside for the conservation of biodiversity.

There have been also a number of international legal instruments. The Convention on Migratory Species provides a certain amount of protection to some very vulnerable members of the land community. And CITES – the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (see Box 7.2) – provides a safety net for some of the world’s most endangered species, including, most recently, maximum protection for the African elephant.

BOX 7.2 CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) was adopted in 1973 and entered into force on 1 July 1975. As of 1992, it had 114 parties.

The treaty is designed to conserve endangered species while allowing trade in wildlife whose populations can support it. CITES bans all commercial trade related to endangered species, which it lists in its Appendix I, and limits and monitors trade related to species at risk of becoming endangered, listed in Appendix II. Appendix III allows countries to prohibit trade in nationally protected species.

The enforcement of CITES is the responsibility of its member states. Governments are required to submit reports and trade records to the CITES Secretariat. A CITES permit is the only legal permit recognized for international transit of a wild animal, plant or product.

The World Conservation Strategy, launched by IUCN, UNEP and WWF in 1980, emphasized three global objectives of living resource conservation: to maintain essential ecological processes and life support systems; to preserve genetic diversity; and to ensure the sustainable use of species and ecosystems. The WCS has been used by more than 50 countries as a basis for national conservation strategies.

Caring for the Earth, launched by IUCN, UNEP and WWF in October 1991, reinforces these objectives and emphasizes the social and economic requirements fundamental to sustainable development. It urges that biodiversity should be conserved as a matter of principle, as a matter of survival and as a matter of economic benefit. The latest in this series, the *Global Biodiversity Strategy*, was published in 1992 by the World Resources Institute, UNEP and IUCN.

On the national level, a number of options must be considered by governments. First, the integration of conservation and development must be accelerated. Many countries may wish to resort much more to the wisdom and stewardship of their indigenous peoples in the management of their surviving wildernesses. These peoples

– the victims of genocide – are often better managers, more disposed to sustainable use and more able to resist the crossed signals sent from the marketplace than are the urban elites who lay down policy.

Second, economic incentives and new financing mechanisms must be developed. Basic principles of environmental economics show that people will conserve more when they have greater security of tenure. The discount rate, to put it in economic terms, falls when actors can expect returns over longer periods of time. This principle is well known – as are others, such as the need to adjust costs to reflect environmental factors – but not so well applied. Policies which send unhelpful signals to the market, such as tax breaks for forest clearing, must be brought into line with current economic and ecological logic, and stopped.

Third, the network of protected areas must be consolidated. This is particularly important in the 13 countries of 'mega-diversity', which stand on the frontline of the battle to save biodiversity. Their policies are critical. The recent delineation of a 100,000 square kilometre reserve in the Yanomami territory of Brazilian Amazonia is to be welcomed and studied as a possible model. The Yanomami have husbanded their resources for centuries. Empowering them to supervise a protected area is a prudent move.

Fourth, with only 1.4 million species identified, our efforts are hampered by a lack of hard information. We must enhance our knowledge base.

Fifth, national laws must be strengthened. Any international convention will sink or swim in the waters of national legislation. National implementation is the single biggest problem associated with international environmental law. It is the duty of all citizens, and of scientists in particular, to ensure that commitments entered into by governments on the basis of scientific evidence are translated into effective legislation at home.

The Earth's biological resources are assets to be conserved and managed for the benefit of all humanity. All nations have the duty to safeguard species within their territories, on behalf of everyone. But a global effort is also needed, to infuse a new spirit of cooperation into conservation.

The Convention on Biological Diversity adopted at the 1992 United Nations Conference on Environment and Development aims at the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of

the benefits arising from the use of genetic resources. This includes issues of funding, of access to genetic resources and of transfer of relevant technologies – taking into account all rights over those resources and technologies. In implementing this Convention, I hope we will be able to save what biological diversity we can, while we can.

TOXIC CHEMICALS AND HAZARDOUS WASTES

The trade in poison

The growth in the global economy has sparked – as well as relied upon – an astonishing surge in the range and volume of chemicals. Every eight hours, a new chemical is introduced. Each year, about 1,000 new chemicals enter commercial use. An estimated 100,000 chemicals are on the market today.

This vast chemical inventory has brought untold benefits to humanity, in food production, health care, industrial processes and consumer products. But it has also brought enormous problems, during use and in disposal.

In recent years world concern about these problems has been growing. Humans release toxic chemicals directly – as fertilizers, pesticides and solvents, for instance – and indirectly in the waste streams of various activities, such as mining, industrial processes, incineration and fuel combustion.

Many of the chemicals released are transported away from their sources to cause widespread contamination of the local, regional or global environment. For example, polychlorinated biphenyls (PCBs) released in industrial countries have been carried by the atmosphere as far as the Arctic. DDT, mercury, lead and other metals have been transported similar distances. The effects of chlorofluorocarbons and other chemicals on the ozone layer and of greenhouse gases on climate are other examples of global chemical pollution.

In the past two decades, focus has broadened out from the direct short term effects of high level exposure to toxic chemicals to encompass chronic effects as well. These chronic effects include birth defects, genetic and neurological disorders and cancer, and are of particular concern to the public. Because little is known about what happens to individuals exposed to very low concentrations over 20 or 30 years, regulation becomes more complicated.

A number of industrialized countries have attempted to control chemicals prior to marketing, in order to protect human health and the environment by ensuring proper handling and use. This task has been complex and slow because the tools for evaluating the effects of chemicals, especially in the long term, are not sufficiently developed. Using laboratory animals to assess risks to human beings is controversial

and there are many uncertainties about the methods used to determine potential environmental threats. Maximum levels of exposure have been set for some chemicals and others, considered too dangerous for marketing and consumption, have been banned or restricted. Less harmful substitutes are also being sought.

During recent years, several cases have come to light where products banned or severely restricted in industrialized countries have been sold to, or dumped on, developing countries. In 1989, UNEP's Governing Council adopted the Amended London Guidelines for the Exchange of Information on Chemicals in International Trade, which included a procedure for prior informed consent (PIC).

PIC can help governments in three ways: it gives them a chance to learn from each other's decisions on the control of specific chemical hazards; it provides them with a yardstick for reviewing their own decisions in the light of others' legislation; and it offers them a global perspective on the potential long range implications for health and the environment. As a start, PIC has been applied to chemicals banned or severely restricted by 10 or more countries; next it will be applied to those banned or severely restricted by five or more.

Over the last decade, the disposal of hazardous wastes has emerged as another vital global environmental issue. An estimated 300 to 400 million tonnes of hazardous wastes are generated around the world every year, around 90 per cent in industrialized countries.

Considerable advances have been made in hazardous waste disposal technologies, including incineration and controlled disposal on land. Between a half and three quarters of wastes are dumped on land – and this proportion is expected to increase, despite growing re-use and recycling of materials. While landfill waste management has improved greatly, major obstacles remain.

Thousands of landfill sites and surface impoundments have been found to be entirely unsatisfactory. Corrosive acids, persistent organic chemicals and toxic metals have accumulated in these sites for decades and are now leaking into groundwater and other media, posing serious threats to health. By 1990, the US Environmental Protection Agency had identified 32,000 potentially hazardous sites. About 1,200 of these needed immediate remedial action. In Europe, 4,000 unsatisfactory sites have been identified in the Netherlands, 3,200 in Denmark, and some 50,000 in western Germany. Clean-up costs have been estimated at \$30 billion in western Germany,

\$6 billion in the Netherlands and about \$100 billion in the USA.

Costs of new landfills are spiralling: in the US it is estimated that the cost of using this method of waste management has multiplied by more than 10 in two decades. Local opposition to waste management facilities has become more vocal. Existing disposal nightmares, ever increasing paperwork and costs have induced many countries to send hazardous wastes overseas.

The international movement of hazardous wastes has become big business. Most waste exports go from one industrialized country to another. On average, a consignment of hazardous wastes crosses an OECD European frontier every five minutes – a total of over 100,000 border crossings each year. In 1988, between 2 and 2.5 million tonnes of hazardous wastes crossed these frontiers. Some 200,000 to 300,000 tonnes of hazardous wastes have been transported each year from EC countries to East European countries.

The majority of these shipments has been legal. But, with the tightening of the controls over transport and disposal, illegal dumping and traffic have increased and become a global issue.

North to South shipments mostly involve disposal or attempted disposal in developing countries that do not have, and are unlikely soon to acquire, environmentally sound facilities.

A large number of unscrupulous – indeed criminal – waste brokers are exploiting the price and regulation differences between developed and developing countries. The problem is particularly acute in Africa, where waste disposal costs at the most \$40 per tonne. Disposal in Europe costs between four and 25 times as much and in the US 12 to 36 times as much.

The world has witnessed the ugly – and immoral – spectacle of waste laden ships sailing the seas in search of unsuspecting ports in the South. We have seen ships abandoning leaking drums of toxic wastes at the dockside in developing countries. We have seen ships dumping wastes under the cover of night.

As the international waste traffic continues to increase, it has become clear that the problem demands global solutions backed by a rigorous national response. In addition, the prospect of South-South traffic – as developing countries push towards industrialization – has underlined the urgent need for prompt and tough action.

Growing international concern, especially in the developing countries, led in 1989 to the adoption of the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal. The Convention stresses the sovereign right of every country to ban the import of hazardous wastes. The Convention also obliges every contracting party to ensure that no shipment is allowed to go to a country that has banned import of the wastes concerned.

The Convention deals with other crucial points. It states that traffic which does not comply with its provisions is not only illegal but criminal; it requires its parties to make laws to prevent and punish illegal traffic; and it defines the responsibility of exporting and importing states with respect to illegal shipments.

The Convention provides for bilateral, multilateral or regional agreements on the movement of wastes, but requires that they should not be less environmentally sound than the Convention. It ensures the exchange of information, based on the principle of notification and prior informed consent. The importing country must advise the exporter – in writing – of its willingness to accept a shipment on the basis of detailed information of what it contains. It requires that the exporting country be assured that the shipment will be disposed of correctly – something which few national laws demanded until recently.

Developed countries which signed the Convention agreed to provide technical assistance to developing countries, so that they could acquire facilities for handling and disposing of hazardous wastes in an environmentally sound manner.

One hundred and sixteen countries and the EC agreed to these points. They represent realistic measures to strengthen the protection of the global environment. They are not, of course, a panacea. Nor is the call by some countries for a global ban on hazardous waste traffic a panacea. A global ban is not the answer. It would lock hazardous wastes inside national borders, where facilities may be inadequate or too expensive to deal with the chemicals involved. A ban would thus act against proper management.

The Convention states clearly that whenever possible wastes should be disposed of close to their point of origin. It is designed to minimize risk from the uncontrolled movement of such wastes and also to enable them to be moved to where they could be disposed of under more environmentally sound conditions. This is already happening in many developed countries, and it will soon be the case for many

developing countries. Regional and subregional waste management facilities in developed countries and especially developing countries can respond to economies of scale and ensure the highest environmental standards. Under a total ban, such progress would be impossible.

The Basel Convention – which entered into force in May 1992 – represents a durable step towards more effective action for global environmental protection. Like the Vienna Convention and the Montreal Protocol on the Protection of the Ozone Layer, it has been designed to be strengthened in the future.

Waste reduction or prevention is the best way to protect human health and the environment. Given the cost and complexity of handling waste, the principle of 'pollution prevention pays' should be widely promoted. The benefits are enormous. Occupational and public exposure to hazardous chemicals is reduced. Industrial efficiency and competitiveness are enhanced as waste prevention cuts raw material inputs, saves energy and reduces the volume of waste that has to be stored, treated, or disposed of. Less waste means less expensive pollution control equipment, less accidents during transport, less off-site hazardous waste facilities and less health, environmental and political problems. Companies can reduce liability risks and costs that otherwise arise from inadequate disposal practices.

Existing technology could eliminate up to 50 per cent of all environmental pollutants and hazardous wastes. So the real challenge now is to act to cut the generation of hazardous wastes to the minimum.

Part III

A COMMITMENT TO THE FUTURE

—

ENVIRONMENTAL PROTECTION

Costing it right

Classical economic theories and practices treated nature as a bottomless well of resources and as an infinite sink for wastes. The economy became disconnected from nature, in theory and in practice.

This approach began to lose its hold in the late 1960s, when pollution became a major concern in industrialized nations. It became clear that the natural process of self regeneration was slow and complicated; if a natural resource was overexploited, its stock would fall rapidly, leading ultimately to its complete destruction. People began to accept that the capacity of air and water to absorb and carry wastes was limited, and that pollution control measures were needed to safeguard the environment and the quality of human life.

If sustainable development is to be achieved, the environmental costs and benefits of any development process must be evaluated. This is not easy. Some of the environmental effects of development can be simply identified and quantified; others cannot. But even partial economic analysis is important because it makes people aware of the fact that natural resources should not be treated as free goods.

Environmental costs arise either through the damage done by resource exploitation or through the effort expended to redress the damage.

In the last two decades, several studies have attempted to cost the damage caused by environmental pollution. For example, the damage caused by air, water and noise pollution in 1986 in the Netherlands was estimated at between \$600 million and \$1.1 billion (about 0.5 to 0.9 per cent of GNP). In Germany, damage from the same sources was estimated at about \$34 billion per year from 1983 to 1985, or about 6 per cent of annual GNP. Generally speaking, the economic cost of pollution damage in developed countries varies between 3 and 5 per cent of GNP.

Such costing is far from complete. Environmental damage is often selective and unequally distributed in time and space and among societies. Many of the physical, biological and socio-economic consequences of large development projects are inadequately known and some cannot be quantified. For instance, when landscapes or historic monuments are threatened with irreversible change, it is hard to place a

price tag on the damage, even if all the consequences could be enumerated and their likelihood assessed.

Or consider the problems of placing a value on a human life. The traditional economic approach has been to equate the value of a life with the value of a person's expected future earnings. This index undervalues those in society who are underpaid and places no value at all on people who are not in income earning positions. In addition, it ignores the suffering of the bereaved, which may be much greater than any measurable financial loss.

According to estimates, the cost of pollution abatement and control in developed countries ranges from 0.8 to 1.5 per cent of annual GDP. In developing countries, the figure is much lower and varies markedly from one country to another.

Pollution abatement studies deal essentially with the direct costs of dealing with such problems as air and water pollution and waste management. They rarely include the expense of environmental deterioration, of loss of natural resources or of their impacts on economic development and on people. Such studies, therefore, generally show the cost of action but not the cost of inaction.

Money spent on environmental policies is an investment for the future. The expense is generally more than repaid by the benefits which result. For example, it has been estimated that the net benefits from air and water pollution control in the United States would amount to about \$26 billion per year. In the developing countries, the construction of drinking water and sanitation facilities could reduce the incidence of infectious diseases by 50 to 60 per cent or even more. This improvement in human health would not only increase productivity and time on the job (both of which add to GNP), but also cut expenditure on medical goods and services, most of which are imported.

Preventing and repairing environmental deterioration often involves forgoing today's tangible economic benefits for tomorrow's intangibles. Let us illustrate this with some examples.

About 6 million hectares of productive land are estimated to be lost every year to the advancing desert, while another 21 million are reduced to zero economic productivity. The resulting loss in agricultural production adds up to some \$42 billion a year.

To stop that loss by holding back the desert would cost \$2-6 billion a year for the next 20 years, over and above what is already being spent today. To any manager this would seem a profitable and attractive investment. But unfortunately the return will not come tomorrow, but in the medium or even longer term. It will be some time before investors can reap the benefits of their savings.

Investors want results today and tomorrow, not promises for the medium and long term. These are real constraints. As a result almost nothing is done to stop the trend of land degradation and desertification.

We must recognize the self interest of governments, industry and special groups and show what can be done within these constraints. We must go on pointing out the links between the lack of environmental management and the failure of development efforts: showing, for instance, that famine is a painful symptom, but desertification and the mismanagement of natural resources are the causes of many natural shortages, and of Africa's recurrent pain.

Famines can be stopped through the introduction of better land use practices. There is no better investment than an investment in prosperity. You cannot promise a return on investments straightaway, but you can point to the danger and futility of feeding one generation of famine victims without ensuring that the next will not starve.

The payoffs from a switch to better management of resources are quantifiable. The present costs of switching to better policies and programmes are small in comparison to the future costs or to the damage that will result if too little is done. The industrial world is finding that the expense of recycling poisonous wastes is nothing compared to the expense of cleaning up inadequately regulated hazardous waste sites – set at about \$100 billion in the US and at \$6 billion in the Netherlands.

Similarly, the developing world is finding that the costs of watershed protection are small in comparison to the costs of increased flooding and of reduced irrigation and hydro-electric capacity.

There is an urgent need for countries to reckon the value of intact resources into their national accounting systems. For example, it is estimated that each year Brazil's Amazon rainforest produces goods – such as rubber, fish and brazil nuts – worth close to \$100 million. It is extremely difficult to assess the Amazon's value as rainmaker (it generates half its own rainfall through evapotranspiration), as genetic storehouse and as freshwater supplier. But it may add up to billions of dollars a year.

In the last two decades, some attempts have been made to adjust national income accounts to register both direct environmental costs and the 'depreciation' of the capital of natural resources. Although national accounts record the income earned from harvesting resource stocks (such as fish, timber and minerals), they exclude the loss of future income as a result of declining stocks and deteriorating environmental quality. If this depreciation is factored in, the net contribution of resource depletion to national income is much lower and more accurately reflects the impact on economic welfare.

When Japan corrected its national income figures to allow for environmental and other factors, it found that GNP had grown by an average of only 5.8 per cent a year between 1955 and 1985, instead of 8.3 per cent as previously believed. It has been estimated that, when physical depletion of petroleum, forest and soil assets are taken into consideration, Indonesia's GDP grew by 4 per cent per year from 1971 to 1984, instead of the reported gross value average of 7.1 per cent.

The message is clear – overuse of resources must be replaced by conservation. The oil price hikes of the early 1970s promoted energy conservation. In industrialized countries today, 20 per cent less energy is used to manufacture the average product than was used a decade ago. Several European countries and Japan have demonstrated that economic growth can be sustained even if energy consumption drops.

We need to get into the habit of adding the environmental dimension into such main indicators of wealth creation as food, technology, energy, commodity prices, financial transactions and borrowing.

Take food, for example. Agriculture is much more than an economic activity, it is also a social and environmental activity. Investment in irrigation will increase productivity – but, without environmental controls, for how long? Inundating land with water will raise production, but, in a tropical climate particularly, evaporating water will suck up salts, leaving an arid hardpan. It has been estimated that as fast as new land goes under irrigation in the Sahel, existing land goes out of production.

This need not happen. Such modern methods as spray and drip irrigation, using available renewable sources of energy, avoid these problems. In Oman and other countries, major programmes are underway to revive traditional irrigation systems which at one point the diesel pump seemed to have doomed to extinction. These

countries are finding that traditional methods combined with the latest know-how can be more productive – and more socially desirable – in the long term. For virtually every environmental problem, there is a technological and scientific fix available – and the promise of something better tomorrow.

So where is the blockage? As mentioned before, promoting environmentally sound development involves forgoing today's tangible economic benefits for tomorrow's intangibles. We must make those intangibles tangible. We must bring the future into today's calculations of profit and loss.

Consider lack of sanitation and safe drinking water – the world's most acute pollution problem, though it is seldom seen as such. According to the World Health Organization, dirty water and inappropriate sanitation causes 80 per cent of all world disease. Waterborne diseases kill about 25,000 people every day and debilitate millions more every year. This is a severe brake on development. A survey carried out in Venezuela dramatically proved the reverse of this equation – when clean water was provided in the countryside, production increased so much that the cost of installing the water supplies was recouped five to seven times over. Intangible into tangible.

Much the same can be said for insect borne diseases and in particular for malaria, to which nearly half the world's population is prone. In Kenya's coastal zone at any one time, one out of every four people is suffering from a bout of the disease. In Africa south of the Sahara, it kills a million infants each year. According to one estimate the cost of developing and marketing the elusive vaccine would probably amount to less than a dollar per life. The economic returns in terms of productivity and social wellbeing would be immense. Intangible into tangible.

The bottleneck, of course, is that it is the poor who would benefit immediately from the improvement in health. The rich nations and the rich elite of the developing nations would benefit in the long term. And though the Brandt Report and other studies make an unimpeachable case for economic self interest, the tangible at the level of policy implementation remains intangible.

Since its birth the Industrial Revolution has had its detractors. The Luddites, wrongly believing that new technology would make them destitute, smashed machines and burned factories. The Luddite episode was the beginning of a long and difficult relationship between industry and the public. It raised a question that is still asked

today: are the interests of industry and its managers the same as those of the general public? A substantial body of opinion remains deeply sceptical of industry's genuine desire to grow without diminishing the quality of the human environment. Such incidents as Bhopal and the Basel and Gulf of Finland chemical spills have reinforced that scepticism.

The relationship between industry, commerce and the environment is a complex one. The goal of industry and of any business is to make a profit, with maximum efficiency. It is not the job of industry and commerce to make major concessions to the environmental lobby out of goodness of heart. The marriage of industry and the environment has less to do with charity and kindness than it has to do with a healthy assessment of the interests of both.

Business is the quintessential adapter. When public opinion made better pay and working conditions inevitable, business was quick to adapt. And when public opinion called for greater responsibility for the environment, industry reacted swiftly, if unevenly.

Japan and Germany stand out as the best examples. Anti-pollution legislation in the 1960s led to a more efficient use of raw materials, to less waste and often to greater profits. Despite plaintive cries that western German industry could never remain competitive while complying with the new environmental legislation, the German economy continues to be one of the world's strongest. In spite of some painful structural adjustments, environmental legislation was shown to be a net contributor to the country's GNP.

In 1970s Japan, they said that higher priced petroleum would strangle the car industry. Nothing like it. Japan came up with a revolution in small car manufacturing, producing more vehicles which ran on less energy. It made low consumption, low waste vehicles and began making a profit out of slag from the motor industry's steel manufacturing.

It is this flexibility and adaptability that we must build on. The industrial and commercial sector knows that the public demands certain standards of environmental responsibility. It can stay ahead by recognizing three basic rules, predicated on the interdependence of commerce and the public, and of North and South.

The first reality is the 'polluter pays principle'. The public of every major industrial nation insists that whoever pollutes the environment must be responsible for setting it

to rights. There was a time when pollution was an externality that could be written off the books of private industry. No longer. Corporate liability has been legally tested in a number of countries in recent years. The Bhopal settlement should be an object lesson. Sandoz was quick to accept liability for the Basel catastrophe. And Exxon paid the clean-up and other costs after the *Exxon Valdez* oil spill.

The 'polluter pays principle' is here to stay. It is costly to get left behind in the pollution game – and industry has realized this. They are not waiting for legislation to catch up. They are not prepared to incur much greater retroactive costs by adjusting after the fact. Right from the drawing board, more and more companies are costing out industrial processes designed to maximize safety, increase feedstock efficiency, recycle whatever can be recycled and treat what cannot. More of this is needed. Much more. It is much more cost effective to be in on the ground floor of pollution control.

The second point follows on from this: 'pollution prevention pays'. Less conservative, less staid businesses are already turning environmental regulations to their benefit. The company which incurs fewest clean-up costs, the company which reduces its feedstock consumption and waste rather than increasing its scrubbing bills, these are the companies which increase their market viability in an environmentally conscious world (see Box 9.1).

There is no doubt that some measures to protect the environment do affect the short and medium term prospects of some businesses. The most flexible and aggressive industries will need to make the most of new standards and turn them to their advantage when they can. In terms of benign self interest, there is a great deal of public relations mileage to be gained.

The third and most controversial point is industrial or commercial diplomacy. This is the business of image building. In the past, businesses that operated in the Third World frequently did so in order to take advantage of lower wages and overheads, less severe environmental regulations and so on. But the situation is changing.

Third World countries are increasingly unwilling to turn a blind eye or to give something for nothing. Businesses that operate in developing countries cannot expect to move in, destroy the environment, then move on. There is a growing awareness among poorer nations that nothing is gained by destroying today's environment at the cost of sustainable economic viability.

BOX 9.1 POLLUTION PREVENTION PAYS

Many examples illustrate the economic feasibility and environmental benefits of reducing or preventing waste. The following illustrate that pollution prevention pays:

- * The 3M Company (Minnesota Mining and Manufacture) executed a 3P programme which entailed more than 2,000 projects. It saved the company \$420 million over 10 years and prevented the annual discharge of 12,000 tonnes of air pollutants, 14,000 tonnes of water pollutants and 313,000 tonnes of sludge and solid wastes.
- * Exxon Chemical Americas installed 16 floating roofs on open tanks of volatile chemicals at its Bayway plant. This resulted in annual savings of 340 tonnes of organic chemicals, worth about \$200,000, in addition to a marked reduction of releases into the environment.
- * The French company Sunkiss developed a low emission paint drying technique. The process reduces the emission of evaporated solvents by 99 per cent, by destroying them in the heating/drying process, cuts drying time by 99 per cent and the energy used in drying by 80 per cent. Energy savings alone recover the cost of the device in two months.

Businesses which are alert to the mood of the times can cash in with well placed diplomacy. For example, there is a Swiss concern which has a large shareholding in a portland cement operation at the Kenyan coast. In the course of operation this company lays land to waste through open cast excavation of coral deposits. But they are also careful to restore the environment. And they make a profit by doing so. They have engaged a small firm of agronomists to replant the quarry pits with indigenous plants, and have introduced benign fauna of various types, turning the area into a tourist attraction. It is a triumph of environmental management, and it allows the company to present its case to local people and to the host government as an industry that is leaving the land as good as it found it.

After years of mutual suspicion and recrimination, we are finally watching a convergence of what our living environment needs, and what investors, consumers and managers want. Industry has become an enthusiastic partner rather than a

reluctant participant in the evolution of international, national and community based environmental policies. And industry is aggressively targeting opportunities in environmental products and services.

The traditional model of industrial activity – which takes in raw materials and generates products for sale plus wastes for disposal – is now being gradually transformed into a more integrated model, an ‘industrial ecosystem’. This optimizes the consumption of energy and materials, minimizes waste generation and uses the effluents of one process as the raw material for another. The ‘greening’ of industry in several OECD countries is demonstrated in more efficient use of energy and water, increased recycling of waste and more development of cleaner technologies.

In addition, a profitable and rapidly expanding industry – the environmental protection industry – has emerged in the last two decades, creating hundreds of thousands of jobs. In the area of air pollution control alone, world orders for equipment reached \$12.7 billion in 1991, more than double the orders a decade ago.

Countries use several economic instruments to protect the environment. Charges, which include effluent charges, user charges, product charges and administrative charges, discourage polluting activities and/or provide money to cut pollution. Subsidies, in the form of grants, soft loans and tax allowances, encourage less polluting behaviour. Deposit refund schemes encourage re-use – of cans and bottles for instance – or more environmentally friendly disposal of waste.

Another type of economic measure is the market creation arrangement, such as a trading arrangement to encourage more efficient and cost effective use of emission permits. The final category comprises financial enforcement incentives, such as non-compliance fees and performance bonds, which provide an additional financial inducement to obey existing environmental regulations. Some 153 different economic instruments are said to be in use in the different OECD countries.

Economic instruments – such as deposit refund schemes, charges on domestic wastes and fines for illegal dumping – are also in use in developing countries. In recent years, a number of countries have reduced or removed subsidies on fertilizers, pesticides and energy, leading to more efficient use. But the huge debt burden and economic problems of these countries present a major obstacle to the introduction of economic instruments. An innovative approach introduced since 1987 has been the

purchase of foreign debts of tropical countries in exchange for the creation of domestic forest reserves (see Box 9.2).

BOX 9.2 DEBT-FOR-NATURE SWAPS

Foreign debt has been purchased at discounts of 50 to 90 per cent on the world market for several years. Generally, it is purchased in exchange for other equity, usually funds in local currency, from the debtor government.

An innovative approach introduced by NGOs is to purchase foreign debt in exchange for the creation of domestic forest reserves:

* Conservation International helped to negotiate the purchase of \$650,000 worth of Bolivian debt for \$100,000. In exchange, the Bolivian government committed 1.5 million hectares of land and maintenance funds to expand the Rio Beni reserve.

* WWF purchased \$1 million of Ecuador's debt, which will be converted into funds to maintain parks and wildlife reserves.

* Costa Rica has recently announced a programme to convert up to \$5.4 million of its external debt, and at least eight other countries are considering similar plans.

Although the subject of integrating environmental management with concerns about economic and social development was raised at the Stockholm Conference, it is still a major arena of debate. Many developments over the last two decades suggest that societies will think very differently in the future about the relationship between nature and human activity. But most of these advances have yet to be institutionalized into governments' and development agencies' policy and planning systems.

ENVIRONMENTAL SECURITY

Intergenerational responsibility

In the past two decades, it has become clear that military means alone cannot provide peace. The security of nations depends equally on economic wellbeing, social justice and ecological stability.

This thinking has led to the evolution of new concepts of security. Such expressions as 'balance of power', 'deterrence', 'peaceful coexistence', 'collective security' and 'common security' make the point that security involves political, economic, social, human rights, humanitarian and ecological aspects, not only military ones.

Environmental degradation imperils the foundations of national security by undermining the natural support systems on which all human activity depends. These processes do not respect man-made borders. They jeopardize not only the security of the country in which they occur but also that of others, near and far.

Regional and global environmental problems have been flashpoints for international tension. But, as we move towards the dawn of a new world order, the progress towards global peace may lull us into ignoring these threats to our planet's survival. National security remains entrenched within the age old narrow parameters of military response. The time has come to appreciate the implications of environmental degradation for national and global security.

No nation – however mighty its armies – can isolate itself from the depletion of the ozone layer, the threat of climate change and global warming, transboundary air and water pollution and the genocide of biological resources.

The environment is the new battleground in the struggle for national security. Behind well publicized ecological disasters lie the more insidious, and more serious, forms of environmental deterioration. Their work is clandestine. Their carnage is global. They have already taken a terrible toll. That is why the ecological agenda is becoming synonymous with the global agenda.

Environmental security must be considered at three levels: national, interstate and global. Natural resource destruction and pollution create strains within national boundaries. Each year the world has 90 million more mouths to feed, but 28 million

tonnes less soil on which to grow its food. Total global food production is going up; but per capita production in parts of India and in large areas of Africa is going down. The drift of refugees from the countryside into slums and shantytowns shows how environmental stress can result in social stress. In countries as different as Thailand, Nepal, Mali and Brazil, deforestation and land degradation have led to open clashes between local people over dwindling resources.

In the North, some reports indicate that 50,000 Americans and Canadians a year will die prematurely because of respiratory and cardiac diseases induced by air pollution. Four out of 10 Americans regularly face unhealthy air quality levels. Nearly 500 waterways in the USA are laced with toxic chemicals, including traces of lead, dioxin, PCBs and other chemical residues. Those affected demand that polluters respect their health. Pollution is a continuous source of strained relations between various sectors of the same society.

Secondly, environmental conflicts may spill over frontiers, involving two or more states. In North America, the ravages of acid rain have created tensions between the United States and Canada. In Europe, acid rain and severe pollution of the Rhine, Rhone and Danube, and of the North Sea have fouled relations between states. The effects of Chernobyl lingered across Europe for a number of years after the accident.

Competition over ever shrinking natural resources is growing. In North America, tensions are mounting over freshwater diversion and national claims to depleting fish stocks.

In the Middle East, tensions have risen not over oil but over the management of water from shared rivers. Can Egypt watch passively while nations higher up the Nile disrupt its livelihood? What about Turkey, Iraq and Syria and their shared river, the Euphrates? How will Niger and Nigeria respond to extensive damming and irrigation schemes in nations farther up the Niger?

In Central America and Haiti, land degradation has forced people to emigrate, creating racial and social tensions. In short, resource depletion is causing new flashpoints in international relations.

On this interstate level, there is also the potential of conflict between North and South. While the rich North expresses concern about tropical forest destruction, multinationals clear land, export tropical timber and exploit tax and labour conditions. Multinationals take advantage of poverty and lax environmental

standards to site polluting industries in the South which would be unacceptable in their own countries. Incidents of 'garbage imperialism' – millions of tonnes of hazardous wastes exported from industrialized countries to developing countries in Africa – have fostered anger and resentment.

On the global level, ecological destruction is as lethal as nuclear war. But its work is covert. For example, each 1 per cent loss in our planet's stratospheric ozone layer is expected to cause considerable damage to health and the environment (see Chapter 2). If present trends in CFC use continue, 60 million cases of skin cancer, resulting in a million deaths, could occur in the US alone by the year 2075. On another front, the destruction of tropical forests and other habitats faces our planet with the greatest mass extinction in 60 million years (see Chapter 7).

These trends are a tragedy in themselves. But they also raise tensions between North and South over who is responsible for the destruction of the ozone layer, and between rich countries who insist on conservation and tropical countries who seek compensation for it.

The greatest threat to the world order comes from the build-up of greenhouse gases leading to climate change and global warming. Our planet is in the midst of the greatest climatic shift since the last great ice age. Then, the ecological face of the Earth was transformed. Forests died. Sea levels changed. Some species became extinct. Others had time to adapt.

Today, time is running out. The Earth's global temperature has already risen by some 0.5°C over the past 100 years. It is expected to increase by another 3°C before the end of the next century.

The most devastating impacts of climate change will be felt in low lying countries including Bangladesh, Indonesia, the Maldives and Egypt. But there can be no mistake – all countries will be affected.

In the USA, grain production could decrease and new pest borne diseases, including Rift Valley fever and African Swine fever, could infect livestock. The horn fly – which already causes \$700 million of damage to beef and dairy cattle every year – could increase. Malaria could spread to the Southern states. Boreal forests could be hard hit.

Coastal defences against rising sea levels could cost hundreds of billions of dollars. If only 1 per cent of the world's projected population by the year 2000 were affected

by sea level rise that would mean 60 million migrants. If 5 per cent were affected, there would be 300 million. What this could mean for national and global security hardly bears thinking about. But think about it we must. Climate change is already creating tension between developing countries who need to develop and use more energy and the North which is trying to curb greenhouse gas emissions.

This threat alone is reason enough for nations to act together for the security of our life support systems. Yet other destructive forces are at work. Our world is being destroyed because people either have too much or too little. The pollution of poverty remains the most inhumane and most destructive force on this planet. The rich can afford to change, to clean up their environment, to increase environmentally friendly consumer goods. The world's poor do not have a choice.

If we want to head off the prospect of 21st century eco-wars, the world will have to mobilize not millions but billions of additional pounds and dollars. The environmental debate in this decade will turn on public expenditure decisions. Saving the world is not going to be cheap.

The debate is influenced by how people perceive security and the nature of the threat to themselves and their families. So much of the rhetoric of security works at the emotional level, appealing to the instinct to protect one's family and way of life from external threat.

In practice, individual and collective security cannot be segregated. Action is mutually reinforcing. There is not much point in the individual taking action unless the government is responsive. And there is not much point in nations taking steps to conserve energy or protect coasts and rivers unless their neighbours do likewise. No country can protect its own patch of the sky.

The debate about environment and security must take place simultaneously on three levels. First, on the personal level. For most of the world's people, for most of the time, security is a strictly local affair – a safe home, a decent standard of living and an ability to take decisions which safeguard the family and community.

Second, on the national level. The first duty of the state is to preserve peace and territorial integrity, by political and military means. But increasingly citizens are demanding that security should be expanded to include their country's environmental quality: clean air, clean water, a secure source of food.

Finally, in the post war period the threat of nuclear war destroying the whole planet forced us to consider global security. Global environmental destruction should make us think in exactly the same terms.

The recognition that environmental impoverishment can lead to instability is a powerful incentive for a new era of action. We need to end the mindset which holds that one nation's security is bolstered by another's insecurity. We must move together, or we will not move at all.

Global action will not be cheap. We will need practical and workable ways of generating revenue and offering incentives for environmental protection. One option is user's fees, so that resources like air, water and forests are paid for. These could be collected by governments and channelled *in toto* or in part into a global fund or funds.

Another option is the 'peace dividend'. The total cost of implementing the Tropical Forest Action Plan, the UN Action Plan to Combat Desertification and of funding global family planning could be met by diverting less than two days of the world's military budget. The current easing of international tension makes this an opportune moment.

A third option, in cases like greenhouse gases, is tradable permits. These should not be seen as permits to pollute, but as incentives not to.

Part, if not most, of these resources are needed for technology transfer. If developing countries repeat the path of resource gluttony and chronic pollution which marked the Industrial Revolution – and which now haunts Eastern and Central Europe – then the destruction of our planet is assured. Eastern and Central European countries and developing countries need to have affordable access to clean energy-efficient technologies. The private sector, which developed these technologies, must be compensated for providing patents, licences, designs, trademarks and proprietary rights to countries which cannot buy them or develop them indigenously. This needs money and is creating friction in international negotiations.

There must be no conditionality attached to the North-South flow of resources for global environmental protection. Developing countries see the causes and cures for their environmental ills differently. It would be a great mistake for the rich to apply conditionality to new aid and loans and thus turn environmental protection into a non-tariff barrier. A genuine global partnership must be struck, sensitive to the needs of both rich and poor.

The inequities in the global economy are a major cause of environmental deterioration and thus of insecurity. After two wasted decades, addressing these inequities will be a formidable and long term undertaking. Despite all the welcome pronouncements by political leaders, there are few signs that action is taking place on the scale and level required.

This is unfortunate because not only the security of the present generation is at stake, but also that of generations to come. It is the responsibility of this generation to ensure the security of future generations.

In *Facing Mount Kenya*, Jomo Kenyatta described the intergenerational relationship the Gikuyu people have with their environment: 'A man is the owner of his land... But insofar as there are other people of his own flesh and blood who depend on that land for their daily bread, he is not the owner, but the partner, or at the most a trustee for the others. Since the land is held in trust for the unborn as well as for the living, and since it represents his partnership in the common life of generations, he will not lightly take it upon himself to dispose of it.'

Our world would do well to follow Jomo Kenyatta's description of the special kinship between man and his land. National boundaries should not obscure the fact that all people – North and South, East and West – are united by common flesh and blood. We are all partners and trustees for the unborn.

The idea of the global village, of interdependence forged by the global economy, has become a potent reality. In the same way the concept of intergenerational responsibility and equity can and must become a central concern in the agenda of the future. As surely as ecology has international implications, it also has intergenerational ones. The present shapes the future. Each decision we make every minute of the day affects the environment and security of future generations.

The concept of sustainable development provides a key point of departure for rethinking our responsibilities. For it demands that the welfare of future generations – including today's children – be brought explicitly into all environment and development planning. It raises concern for a new type of fairness and equality rarely considered previously – intergenerational equity.

This must now take its place among concerns for equality between races, sexes and nations. The struggle for these has been hard, even though the participants have been present and able to fight for their rights. Equity between the generations is a

more difficult goal, as the unborn are not present to make their concerns known. We must accept responsibility for future generations. This may be the foremost challenge facing policy makers in the closing years of the 20th century and beyond.

In the past, it was commonly assumed that the next generation would take its chances in a planet very similar to the one inhabited by the current generation, perhaps with new technology to make life safer, healthier and easier. This is no longer a justifiable assumption.

The present generation is the first to have the power to alter planetary ecosystems radically and to present its offspring with a planet very different from the one it inherited. This generation has betrayed those to come. Our planet faces an onslaught of ecological genocide – an assault which includes the prospect of global warming, ozone layer depletion, chronic soil erosion, deforestation and desertification, spiralling air and water pollution. All threaten the health and prospects of our children and grandchildren.

The concept of intergenerational equity poses major challenges in the fields of law and economics. In 1989, a United Nations University study proposed three basic principles: each generation must conserve natural and cultural diversity, so that it does not unduly restrict the options of future generations, and each generation is entitled to a diversity comparable to that of past generations; each generation must pass on the planet in no worse a condition than it was received, and is entitled to a quality of the planet comparable to that enjoyed by past generations; each generation should provide its members with equitable rights of access to the legacy from past generations. Thus justice between generations involves not only duties but also rights, not only between generations but between members of the same one.

How do we get people in the street, as well as in the corridors of power, to understand and embrace intergenerational equity? The need is urgent. Today's destruction closes the options of future generations, who have no say in what we do.

There are isolated signs of hope. The groundswell of public concern about ecological deterioration has triggered international cooperation never witnessed before. We are all getting closer to each other: not only governments, but different sectors and academic specializations. Industry and environmentalists, for example, have stopped locking horns and started a fruitful dialogue on how to reduce carbon dioxide emissions, halt CFC emissions and find better agricultural and production methods.

Concern for the environment is prompting a cross fertilization of knowledge.

The reality of a global society is finally getting through. The promise of a wider and wiser perception of justice is emerging. Our best hopes for future peace and global security rely upon strengthened international cooperation to protect the web of life support systems that we destroy, so ridiculously, day in and day out. We share only one planet. We – and future generations – have nowhere else to go.

EPILOGUE

A duty to hope

«More than ever before man and his environment are inseparable; the environment basically conditions man's life and development and he in his turn improves and ennobles his environment by his presence, his work and his contemplations. But man's creative capacity will only bear true and lasting fruit insofar as man respects the laws which govern the vital force and regenerative capacity of nature; man and nature are thus interdependent and share a common future.»

Pope Paul VI, Stockholm, 1972

Over the past 20 years, our knowledge of the environment has grown significantly. Ecology and environmental sciences have matured. In some cases, we have been able to turn the theories of 20 years ago into fact, in others to dismiss them entirely or to uncover new areas of concern.

Desertification is a case in point. It was scarcely mentioned at Stockholm, but today – with arable and grazing land being turned to desert at an alarming rate – it is seen as one of the most devastating environmental problems.

A subtle change of emphasis has taken place during the past 20 years, from worrying about changes in the state of the physical environment to concern over the causes and impacts of such changes. Our perceptions and our understanding have evolved.

Twenty years ago, preserving wild plants and animals was seen as a worthwhile activity in itself. Today, there is widespread recognition that the future of agriculture and of the pharmaceutical and other industries hinges on the conservation of wild species. In the same way, we have come to regard forests, soil, fish, clean air, fresh water as resources to be nurtured. Conservation is no longer seen as vaguely desirable, but as crucial to our survival.

We have also come to realize that everything in the environment is related to everything else. Atmospheric ozone depletion, climate warming due to the build-up of greenhouse gases, acid rain and nitrogen shortages in the soil used to be seen as

separate problems, soluble on their own. We now know they are closely linked through the global cycles of carbon, oxygen, nitrogen and sulphur.

Harsh experience has shown that environmental neglect in one quarter can have harmful consequences elsewhere. The useful life of some dams, for example, has been halved by siltation caused by unchecked deforestation in watersheds far away. Environmental neglect can have repercussions way beyond national borders. Oil spillage is a problem for all nations which share a common sea; acid rain causes problems in polluting countries but even worse ones in countries with the misfortune to lie downwind.

During the past 20 years, we have noted that some ecosystems have displayed remarkable resilience to our transgressions. Yet they have also displayed their limits. Loss of grasslands and forests, unwanted changes in freshwater systems and declines in the productivity of coastal waters have been among the penalties we have paid.

Stockholm accepted the idea that the solution lay in an environment-based development which enhanced rather than damaged the planet. Then, it was a revolutionary concept; today, it is common currency among decision makers. Strategies, action plans, programmes and guidelines have resulted. All this culminated in the convening of the United Nations Conference on Environment and Development in Rio de Janeiro in June 1992.

Unhappily, governments have not matched this developing environmental knowledge with deeds. The concepts of environmentally sound development have been imperfectly or too slowly applied. In some cases they have been ignored entirely.

As a result, the fundamental objective of Stockholm – to protect and enhance our environment for future generations – has not been fulfilled. On virtually every front there has been a marked deterioration in the quality of our shared environment. Just when we need more housing, more food, more jobs, more fresh water, the planet's capacity to meet those needs is being undermined.

A recent analysis of the state of the world environment, described in more detail in my book *Saving Our Planet*, revealed several important trends over the past 20 years.

Gains have been made in specific areas in industrialized countries – urban air quality, cleaner technologies, reduction of vehicle weight, cuts in the use of natural resources and the amount of energy used per unit of GDP. However, not one single

issue earmarked for action in Stockholm has been solved. In most developing countries, the environment has further deteriorated. Globally, new issues pose unprecedented threats; ozone depletion, climate change and the loss of biological diversity.

Secondly, the world population of 5.4 billion people is expected to leap by 1.7 billion in the next two decades, by far the largest increase in human history. Population may reach an equilibrium of 10.5 billion by the year 2110 or it may surge to approximately 14 billion. This will be coupled with a dwindling of the world's natural resources, carrying capacity and ability to assimilate pollution.

Since the 1970s, there have been impressive gains in agricultural productivity. Yet, because of population growth, 90 million more people were chronically hungry in 1990 than in 1970; about 1.1 billion people in developing countries live in poverty; over 10 million children suffer from severe malnutrition; 35,000 to 40,000 children die each day from diseases related to the environment. Largely because of environmental deprivation, a baby born in Africa can expect to live to 52 years, an astonishing 20 years less than one born in Europe or North America.

Finally, the average per capita GNP in industrialized countries is 18 times higher than in developing countries.

To concentrate only on these negative statistics would give a distorted picture. The two decades since the Stockholm Conference have seen a considerable degradation of the global environment and a squandering of resources. But there are also grounds for optimism.

A growing appreciation of the global nature of environmental problems has led to a new and more serious approach to these issues, especially since the mid-1980s. Governments have become more willing to work together – as shown by the successful negotiation of the Montreal Protocol, its dramatic strengthening in 1990, the Basel Convention and more recent conventions on biodiversity and climate change.

At the national level, in the early 1970s only a few countries had government departments concerned with environmental management. Today most countries have some form of environmental machinery. National environmental laws have increased and diversified; so have non-governmental bodies dealing with environmental issues.

Environmentalism has grown over the last two decades, and it has adapted to the times. Modifications to social cost-benefit analysis, the onset of environmental impact assessment and auditing, risk analysis, new laws at national and international level and the activities of NGOs have all helped.

Meanwhile, the world has not been standing still. Since 1972, the global political and economic landscape has altered, not gradually but in a number of dramatic and unforeseeable upheavals. The ideological and economic world maps of 1972 are no longer valid in 1992; the geopolitical assumptions which accompanied them no longer hold true; and the predictions of social change which were based on them have been proved inaccurate.

The most dramatic and obvious political change has been the most recent. Since the introduction of perestroika in the mid-1980s, the movement to democratic pluralism and the upheavals in the former Soviet Union, Central and Eastern Europe have gripped world attention. The bipolar world in which two superpowers and their supporters faced each other across an ideological and political abyss has passed away – creating both opportunities and uncertainties. It may be some time before the new geopolitical map is finally drawn. Its nature will owe much to the fundamental causes of these changes.

The radical optimism of the early 1970s gave way under the pressure of the global economic recession which followed the second oil shock in 1978. The Second UN Development Decade and the call for a New International Economic Order had been underpinned by the belief that institutional solutions could be found to human problems. This was now replaced by a more individualistic, inward looking, market oriented philosophy.

Paradoxically, the same improvements in mass communications which have liberated people and fuelled popular demands for political reform have also led to an increased sense of individual helplessness in the face of mounting environmental crises. People have lost trust in politically generated solutions.

The new protectionism which followed the recession of the early 1980s has affected the exports of developing countries. Their access to Northern markets is restricted by non-tariff barriers, voluntary export restraints, direct and indirect subsidies and other obstacles.

Over the past 20 years, both the World Bank and the IMF have shifted their

development priorities from import substitution to export led growth, accompanied by severe structural adjustment programmes.

Most developing countries have little to export but natural resources. Commodity prices have fallen steadily since the early 1970s. By 1986, average real commodity prices were at their lowest recorded levels this century (with the single exception of 1932, the trough of the Great Depression). The World Bank forecasts that commodity prices are unlikely to rise during this decade, with intensified South-South competition in saturated markets.

Debt servicing and reduced aid lead to a net financial flow from the South to the North. Developing countries pay about \$65 billion a year in interest on their debts and receive about \$50 billion in official development assistance. Increasing interest payments on a spiralling debt burden can only be met by increasing exports.

For countries that are almost totally dependent on commodity exports in a hostile market, this means placing greater pressure on the environment and further reducing living standards. As populations rise, the pace of environmental degradation seems certain to increase, unless the debt crisis is resolved and greater equity introduced to the world's commodity markets.

Putting the world on the path of sustainable development will not be easy, given the environmental degradation and economic confusion which now prevail. Sustainable development is not a slogan, but rather an exacting and demanding process. Meaningful reforms and bold policies are needed. Perceptions must be transformed, beginning with how we rate the environment. Our natural resources – fresh air, clean water, virgin forests – have been undervalued, even regarded as economic free goods. This must change.

Two hundred years after the death of Adam Smith, economic and ideological debates perhaps distract many from what I see rather clearly: too often, economics has been wrong. We have been wrong about natural resource scarcities, pollution carrying capacities and the ecosystems upon which all economic life is based. We have been wrong about the value of our natural patrimony. And now we are paying the price for our ignorance and arrogance.

Too often the 'invisible hand' of the market economy has been the absent hand, with too soft a touch. So precious resources like air and water have been priced as free goods, and pollution has been written off as an externality.

Getting development and conservation to work together means curing the myopia of some economists. The reforms should involve fresh planning and policy approaches to agriculture, energy, industry, direct investment at home and abroad, fiscal, monetary and trade policies.

Sustainable development does not mean slapping environmental considerations onto project planning. It does mean radical reform – to sharpen the explicit linkages between national income accounts and the natural resources upon which so many economies depend. The conventional barometers of wealth – income, GNP and GDP – have systematically provided false signals about a country's natural capital. And false signals are also dangerous signals. Since the Industrial Revolution, they have been beckoning industry and individuals to pursue fast track economic growth based on ecological deficit financing.

We must get the true cost of natural resource use and pollution added into the final price of goods and services. We have the tools, such as input-output analysis, cost-benefit analysis, environmental impact assessment, adjustments in marginal opportunity costs and discount rates. We must make them work in favour of intergenerational responsibility and equity. If we get our economic assumptions right, then other sources of destruction – including misdirected incentives and subsidies – can be adjusted.

As we move to the 21st century, the world desperately needs to agree on solutions which will set it on a new course. Development planning and implementation will have to change significantly, the global economy will have to be fundamentally restructured, and there will have to be a quantum leap in international cooperation.

There is now a broad consensus that industrialized nations cannot remain immune from an environmentally induced economic collapse in the developing world. The need for a more just, less consumptive economic order has won wide acceptance. But we have yet to see these concepts applied in any meaningful way.

If global partnership is to mean anything, it must revolve around progress in four areas. First, debt relief must be accelerated, commodity prices stabilized and fair terms of trade found. Developing countries are not looking for a handout. Instead, they want a fair chance to avoid the unsustainable economic paths which industrialized countries have pursued for so long and can now afford to reject.

Second, environmental economics should be integrated into major industrial and

resource based sectors. By working to get the prices right, we can also get agriculture, energy, transport and other subsidies right, and build in incentives that work for sustainable development.

Third, success in dealing with such global issues as climate change, ozone depletion and biodiversity depends on genuine partnership and support for developing countries.

Finally, financial commitments are needed for the transfer to the South, and development in the South, of benign technologies. Unless additional funds are made available, the climate change and biodiversity conventions could become yet another economic roadblock to the sustainable development of the global South. We must not, and should not allow that to happen.

North and South each hold in their hands the keys to efforts which can benefit all. The North has at its command the lion's share of the world's capital: many decisions on trade, financing and debt therefore require its cooperation. The South, on the other hand, sits astride the world's greatest natural assets: the forests that are the lungs of the Earth, the minerals that feed heavy industry, the biological diversity which underpins global agricultural and pharmaceutical research.

The current imbalance between North and South must be addressed, and seriously. The Third World, with 77 per cent of the world's population, consumes 12 per cent of the world's natural resources and 18 per cent of its energy. The South needs a clear recognition from the world that it must develop. But it also needs help to avoid destructive development. It needs increased official aid, new sources of funding and access to new and improved technologies.

We have the power to design a better future; to use science and technology not only to safeguard but also to enhance the quality of our shared environment. We know too what the major challenges are. We can overcome the problems we face today. We have, as Barbara Ward said, 'a duty to hope' that humanity, which has created all the problems outlined in this book, will mend its ways.

A COMMITMENT TO THE FUTURE

Sustainable Development and Environmental Protection

« The concept of sustainable development provides a key point of departure for rethinking our responsibilities. For it demands that the welfare of future generations – including today's children – be brought explicitly into all environment and development planning. It raises concern for a new type of fairness and equality rarely considered previously – intergenerational equity.

This must now take its place among concerns for equality between races, sexes and nations. The struggle for these has been hard, even though the participants have been present and able to fight for their rights. Equity between the generations is a more difficult goal, as the unborn are not present to make their concerns known. We must accept responsibility for future generations. This may be the foremost challenge facing policy makers in the closing years of the 20th century and beyond. »

Mostafa K. Tolba

